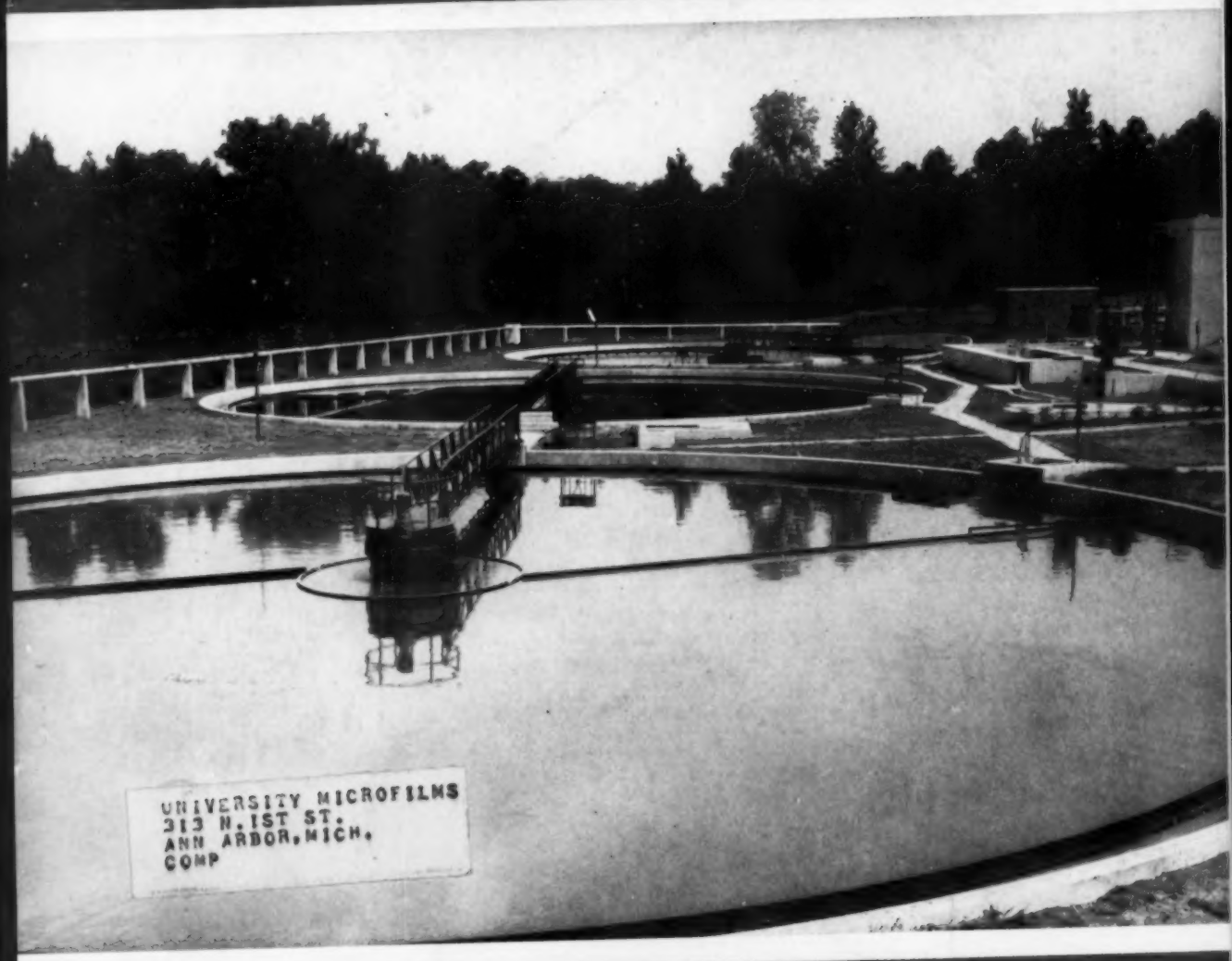
WATER & SEWAGE WORKS

WATER SUPPLY • SEWAGE DISPOSAL

A Scranton Gillette Publication



UNIVERSITY MICROFILMS
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NOVEMBER 1956

The New 10 mgd Bio-activated Sludge Treatment Plant of Charlotte, N. C.
A combination of industrial waste shock—absorbing filters and activated sludge
(Pages 485-489)

Legal Aspects of Water Fluoridation
(Pages 493-495)

Toxicity of Six Algacides on Thirty Algae Growths
(Pages 509-512)

As the world's tallest and most forbidding mountain peaks have at last succumbed to the determination and initiative of man, so, many of the problems encountered in pipeline installations have been overcome by the versatility of Lock Joint Concrete Pressure Pipe.

Whether it must be installed in swampland, on steep grades, in a maze of underground city utilities or in the limited confines of a plant, Lock Joint Concrete Pressure Pipe can be laid bottle-tight, rapidly and with ease; and the trench can be backfilled immediately to avoid expensive ditch maintenance.

Once laid, its qualities of durability, trouble-free service and permanent high carrying capacity will eliminate the necessity of costly re-excavation for repairs, replacement or cleaning.

Installing 78-inch Lock Joint Prestressed Embedded Cylinder Pipe for cooling system of new Tidewater oil refinery.

36-inch Lock Joint Reinforced Concrete Cylinder Pipe was installed through Florida swampland.

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Sales Offices: Chicago, Ill. • Columbia, S. C. • Denver, Col. • Detroit, Mich. • Hartford, Conn. • Kansas City, Mo.

Pressure • Water • Sewer • **REINFORCED CONCRETE PIPE** • Culvert • Subaqueous

ALL NEW DESIGN!

Simple...Foolproof...Low Cost

1500 WATT HOMELITE GENERATOR

Model 35A115
Homelite Generator
1500 Watts, 115 Volt
60 Cycle AC
90 Pounds

Easy to Carry...
...Easy to Use

1. New Money-Saving Features . . . No DC brushes; just two easy-to-get-at collector ring brushes . . . No commutator or DC windings . . . No intermediate couplings; armature keys directly to shaft. Fewer parts to wear out — longer trouble-free generator service.

2. Constant Voltage . . . less than 4% change from no load to full 1500 watt capacity . . . assures long service life for your electric tools . . . guarantees top performance at all times.

3. Overload Capacity . . . 1500 watt continuous duty with generous overload capacity prevents tool stalling under heavy loads . . . insures uninterrupted service even when starting loads exceed operating loads.

4. Compact and Lightweight . . . one man can easily carry this generator wherever you need electricity to power time-saving electric tools. No need for long, hazardous power-consuming cables.

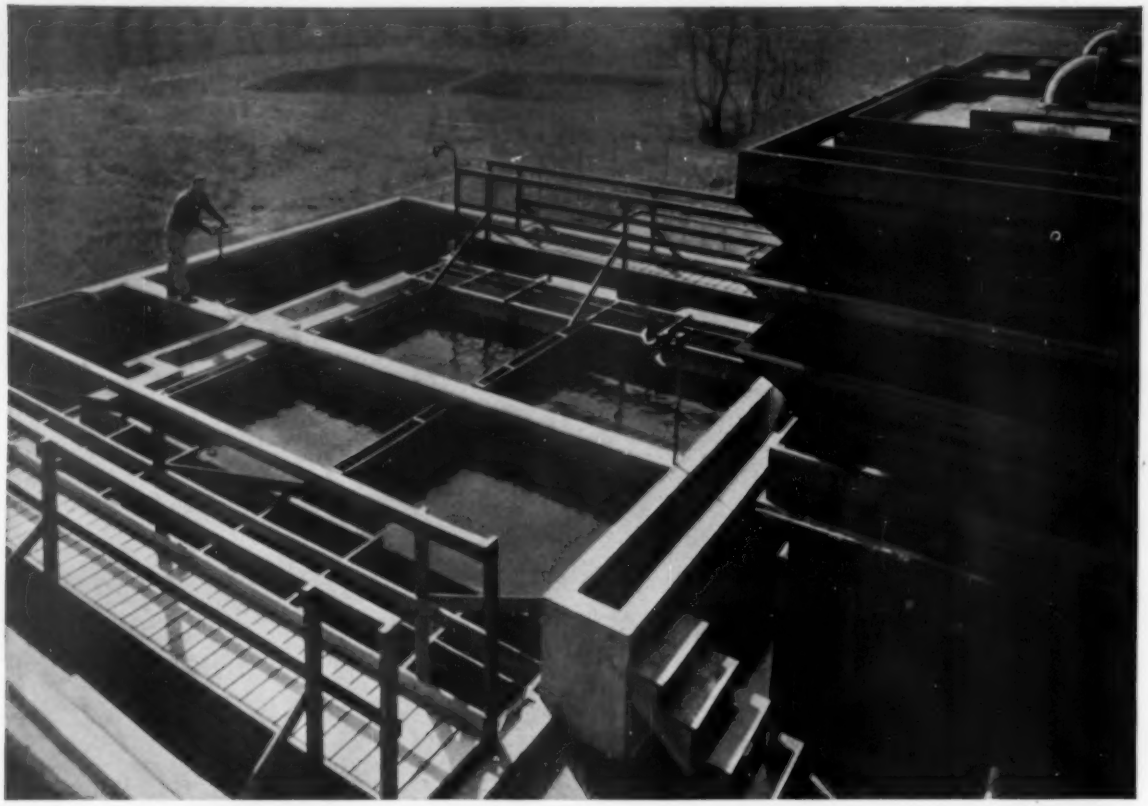
Whatever tools you want to operate — electric soldering irons, drills, floodlights, grinders, hammers, the new Homelite 35A115 generator can save you money. For a free demonstration or additional information, call your nearest Homelite representative.

SAVE EVEN MORE! New Homelite electronic idle control unit, available as optional accessory, runs engine at idle speed when no current is drawn . . . automatically brings engine to full speed when load is applied.

Ask your Homelite representative to show you how this easily-installed accessory reduces engine wear . . . increases service life . . . cuts fuel consumption.

HOMELITE
A DIVISION OF TEXTRON INC.
711 RIVERDALE AVE., PORT CHESTER, N. Y.

Manufacturers of Carryable PUMPS • GENERATORS • BLOWERS • CHAIN SAWS



Raw well water with 30 parts per million of iron enters the double coke-tray Permutit *Aerator* (right) which oxidizes the iron and reduces CO_2. Next step is the Permutit *Precipitator* (left) where lime is added to raise pH and precipitate the iron . . . clay to thicken the precipitates. The resulting floc forms a suspended sludge blanket that speeds the chemical reaction . . . makes it more complete. Final treatment is by 5 Permutit Pressure Filters which remove remaining traces of precipitated iron and turbidity to deliver clear, iron-free effluent.

How *Fairless Hills* reduces iron from 30 to 0.14 ppm!

Fairless Hills, Pa., was built from the ground up to a community of 6,500 in less than 4 years . . . yet, because of good planning, there has never been a water supply problem. Before construction began, the search for water was underway.

The first test wells were disappointing . . . couldn't deliver enough. The nearest river water supply was too dirty and within the tidal basin. And when an adequate well water supply was discovered, it was acid and contained not just the usual few tenths ppm of iron but well over 30 ppm . . . 100 times the allowable standard!

Since even a few ppm of iron are considered difficult to handle, 30 parts presents a real problem. Because of the efficiency of its unique sludge-blanket design, a Permutit *Precipitator* was provided under specifications prepared by Consulting Engineer Howard A. LeVan, Jr. of Harrisburg, Pa. The unit was guaranteed to reduce iron to not more than 0.3 ppm.

"Now, the iron content is 0.14 ppm and the pH is 9.0. This equipment is doing a good job," reports H. D. Markle, Chief Engineer for the builders.

"In 29 years around the country, I've seen numerous Permutit installations doing a good job," adds Township Sup't. of Sewage and Water Supply, W. W. Willis.

It's easy to see why you should bring your water problem to Permutit. Address: The Permutit Company, Dept. W-11, 330 West 42nd St., New York 36, N. Y.

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WATER & SEWAGE WORKS

WATER SUPPLY • SEWAGE DISPOSAL

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185 North Wabash Ave., Chicago 1, Ill.
E. S. Gillette, President & Publisher
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EDITORIAL OFFICES

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Vol. 103 **NOVEMBER 1956** **No. 11**

Charlotte's Newest Sewage Treatment Plant 485
by George S. Rawlins and Thomas H. Tassos

Notes on Water Works Law 490
by John H. Murdoch, Jr.

New England Water Works Assn. Convention 496

What's In Our Future? (Dear Bill Letter) 500

Disinfection — Part 3 501
by George E. Symons, Ph. D.

Distribution System Problems 506

Toxicity of Six Chemical Compounds to Thirty Cultures of Algae 509
by Thomas E. Maloney and C. Mervin Palmer

South Dakota Water & Sewage Conference 514

Concentric Orifice Diameters 515
by Alexander Goldstein

Recent Developments in the Composting of Organic Wastes 522
by Robert F. McCauley

Meet Our Executive Vice President 528

Meetings Scheduled 80A

New Equipment 84A

Manufacturers' News 96A

Literature and Catalogs 106A

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"I can forget them"

Public Works Superintendent Floyd Bailey says his Fairbanks-Morse bladeless sewage pumps haven't clogged once since they were started up three and a half years ago. This has given him more time to spend on his other duties like road maintenance and the water supply system.

The place is Blountsville, Alabama—population 695. You'll find Fairbanks-Morse sewage pumps doing equally reliable jobs in New York and Washington . . . in Los Angeles and San Francisco.

Fairbanks-Morse builds pumps for all magnitudes of water supply and sewage disposal . . . and the motors and engines to drive them. If you are outgrowing your municipal utilities, please give us the opportunity to work with your consulting engineers. Fairbanks, Morse & Co., Dept. WSW-11, Chicago 5, Illinois.

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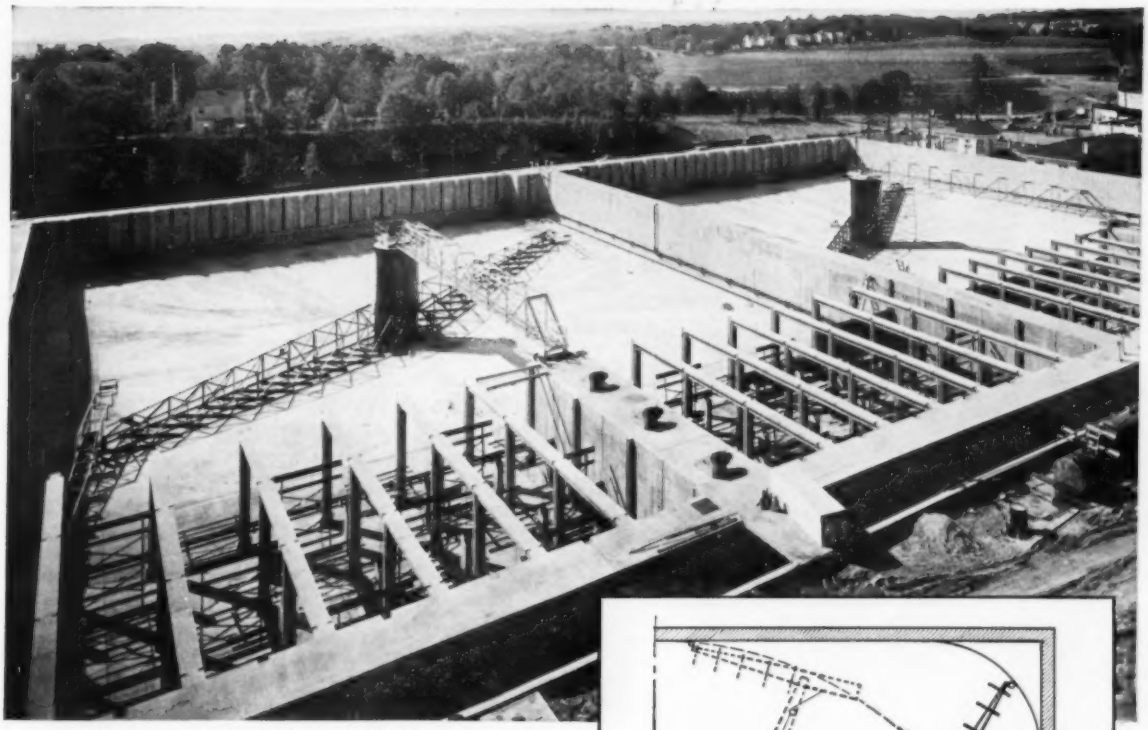
LINK-BELT supplies Baltimore's Ashburton filtration plant with

circular collection in square tanks



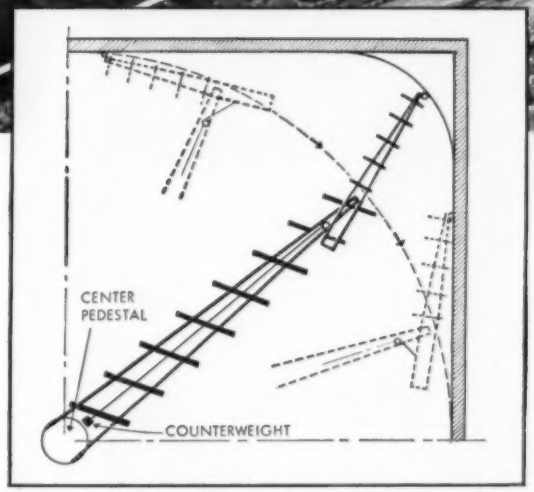
LINK-BELT "SC" CIRCULINE SLUDGE COLLECTORS are shown in two of four tanks at Ashburton plant. As arms revolve, scrapers move settled sludge toward sump in center of tank. Link-Belt Straightline slow mixers are in foreground. The Arundel Corporation, Baltimore, general contractors; Mr. B. L. Werner, City Water Engineer.

Design permits efficient sludge removal with economical tank construction

Chief advantage of rectangular settling tank design is the savings it offers in wall construction and piping costs. In addition, unit construction with slow mixers gives uniform distribution in the settling tank and prevents floc break-up. By choosing rectangular tanks with Link-Belt "SC" Circuline Collectors, the city of Baltimore, Md., was able to combine the benefits of both at its Ashburton water filtration plant.

Link-Belt has pioneered many advances in sanitary engineering. Today, 35 years' background and a broad line of built-to-last equipment support every Link-Belt recommendation.

A call to your nearby Link-Belt office will put you in touch with a treatment specialist. He's ready to work with your consultants and chemists . . . bring you the finest in modern equipment, for any water, sewage or industrial waste treatment requirement.

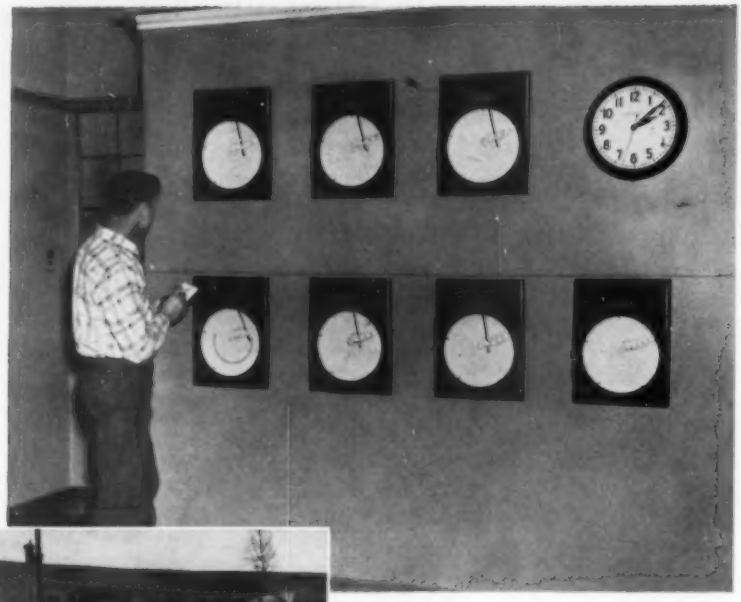


RAKES attached to collectors at each end have wheels which roll along metal curb around bottom of basin. Cable and counterweight assure constant rake contact against guide curb.

LINK-BELT

SANITARY ENGINEERING EQUIPMENT

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 14.214



Brown indicating, recording, totalizing flow meters (top) for raw sewage and treated effluents, and (bottom) for air, return sludge flows and excess sludge. Raw incoming sewage is mixed with sponge-like, biologically-active sludge which absorbs pollution matter in the sewage. Sewage then flows to a clarifier, where sludge settles out, and clear, treated water overflows to the river. A portion of the settled sludge is reactivated in an aeration tank and is returned to the system to treat more sewage. Excess sludge is pumped to digesters.

Brown concentric-scale, indicating, float-actuated flow transmitter is used with a Parshall flume.

Brown Parshall flume indicators and air flow recorders are mounted outdoors near clarifiers and aeration tanks at the Biosorption sewage treatment plant in Austin, Texas.

Brown Instruments chosen for new, cost-cutting Biosorption Process at Austin, Texas plant

THIS SEWAGE PLANT at Austin used to be a standard activated sludge operation. By converting to the new Infilco Biosorption Process, the plant increased its capacity 167%, saved $200,000 in initial costs.

As in a growing number of sewage plant installations, Brown instruments provide operators with accurate working information . . . assure efficient, economical operation.

Brown flow meters indicate, record and totalize flow rates of raw sewage influent, clarified effluents, air, sludge returned to the system, and excess sludge. Orifice plates are used with air flows, Venturi tubes with return and excess sludge flows, and Parshall flumes are used with raw sewage and clarified effluents.

For your own water or sewage treatment processes, there are Brown instruments to cover practically every measurement and control requirement. For a discussion of your particular project, call your local Honeywell sales engineer. He'll welcome the opportunity to talk things over with you and your consulting engineer . . . and he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

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As a dependable *rated* source of chlorine, HTH is the best product of its kind. It contains 70% available chlorine. It's dry, granular, non-dusty, fast dissolving. It's clean and white . . . yields clear solutions. HTH is stable, too, and you'll find it easy to store without extra care or precautions on your part.

Use HTH in tablet form if you require a slower dissolving source of chlorine—one which will maintain chlorine residual over a long period of time (for example, sanitizing new pipe lines).

Both HTH Granular and HTH Tablets are available in 100-lb. drums and in cases of small-size cans. For more detailed information, just call your HTH supply house or mail the coupon below.

3506

MATHIESON

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Industrial Chemicals Division
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Please send complete information on HTH for water treatment applications.

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Let these Westinghouse men help you cut electrical construction costs on water and sewage systems

Co-ordinating the almost endless details of electrical construction for pumping stations, filtration plants, sewage disposal plants and the like is a job for specialists.

Doing it by teamwork can simplify problems, cut costs. It is accomplished by employing specialized know-how on each phase of the specs.

Westinghouse, where ALL types of apparatus for such construction are available in an integrated line, also provides the specialists. Right in your area is a Westinghouse electrical construction engineer who can bring to your problems a team of men tops in their special fields . . . low-voltage distribution, switchgear, motor applications, motor controls, plant or area lighting, ventilation or air conditioning and a host of others.

No job is too small for technical collaboration from your Westinghouse field engineer and his team. No job is too big for them to demonstrate practical savings and technological advantages. Typical applications of Westinghouse apparatus in water and sewage systems are shown below.

Your Westinghouse electrical construction engineer is as close as your telephone. Call him.

Westinghouse Electric Corporation, P.O. Box 868, Pittsburgh 30, Pa.

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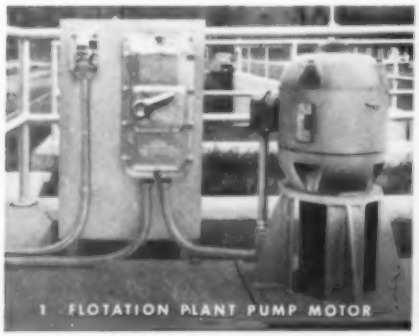
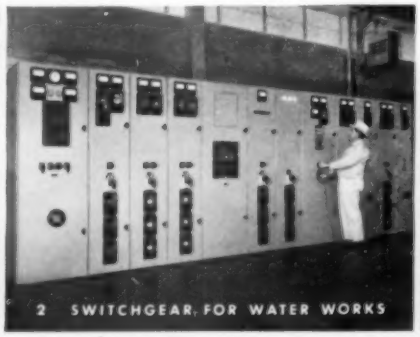


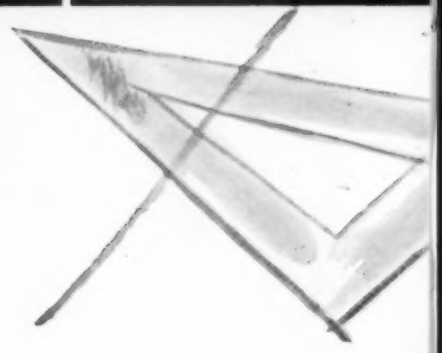
1 FLOTATION PLANT PUMP MOTOR



2 SWITCHGEAR FOR WATER WORKS

3 3400-GPM WATER PUMP MOTOR

1. Vertical-type circulating pump for flotation beds, in Cincinnati, Ohio, driven by 100-hp Westinghouse Life-Line® motor. 2. Block-built from unitized assemblies, this metal-clad high-voltage switchgear vault receives incoming power for the Houston, Texas, Water Works System. 3. Westinghouse 200-hp, 1800-rpm, drip-proof motor driving a 3400-gpm pump at the Gloucester, Mass., pumping station. 4. Simplicity, safety, ease of maintenance are featured in this Westinghouse control center and switchgear distributing power for the San Jacinto, Calif., Water System. 5. 500-hp Westinghouse compressor motor serving a modern power company building. 6. Co-ordinated Westinghouse motor control for the compressor motor shown in illustration 5.



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*WHERE **BIG** THINGS ARE HAPPENING FOR **YOU**!*

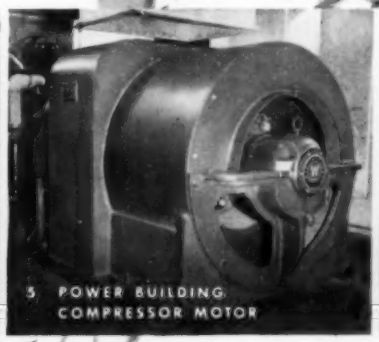
WATER WORKS

SEWAGE PLANTS

TUNNELS, BRIDGES, DAMS

PLANT AND AREA LIGHTING

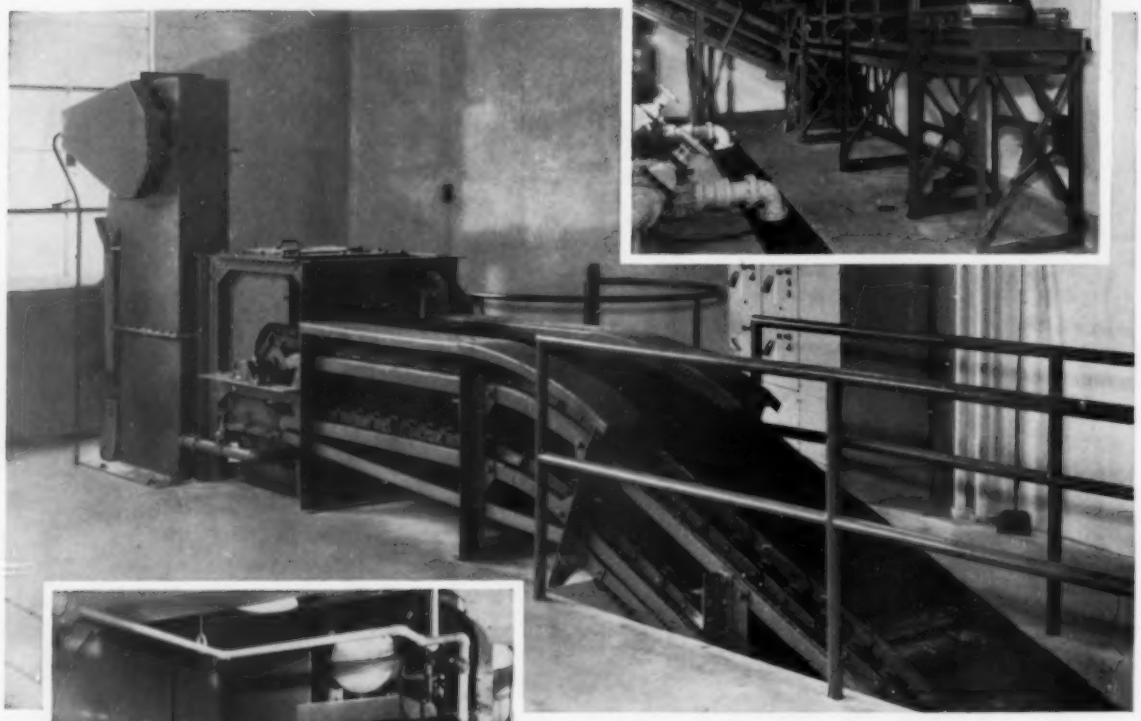
4 CONTROL CENTER FOR WATER SYSTEMS



5 POWER BUILDING COMPRESSOR MOTOR

6 MOTOR CONTROL UNIT

Trucks dump garbage into this hopper. A slow-moving apron conveyor discharges onto the faster-moving apron conveyor, thinning out the material.



This apron conveyor drops the garbage into a Jeffrey Type B grinder. The bucket elevator at the left discharges grit from the washer seen below.

From the grinder the garbage passes into the washer where grit is removed. The organic slurry overflows into the slurry tank and is pumped to the digesters.

JEFFREY

recommends dual garbage-sewage disposal for low operating costs

Garbage can be economically disposed of with sewage solids. Jeffrey sanitation engineers have found that garbage solids can be ground and pumped directly to digesters. Grit is removed first, of course. That is the system illustrated here at the new treatment plant in Kokomo, Indiana.

For help on any treatment plant problem, write to The Jeffrey Manufacturing Company, Columbus 16, Ohio.

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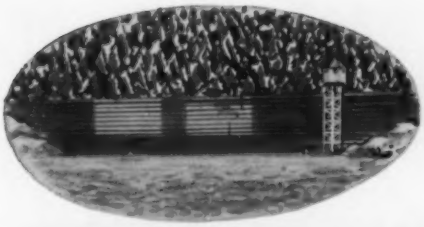
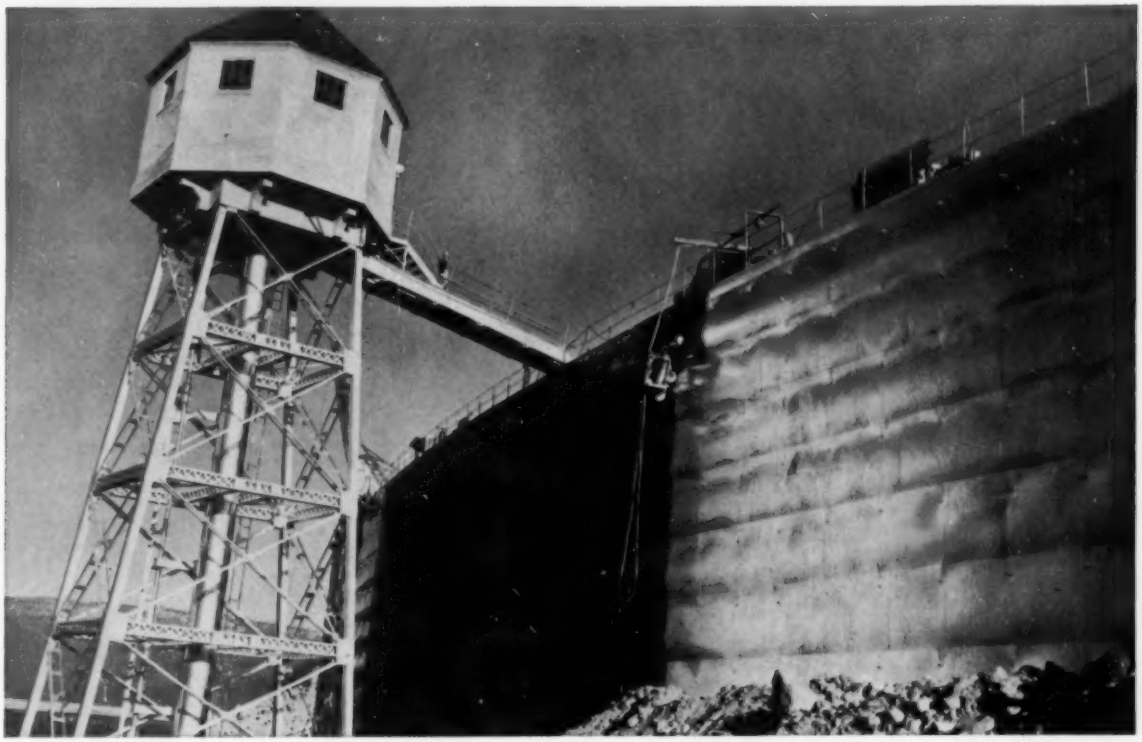


New TARSET®

selected for Maximum Protection of Big Dam Facing

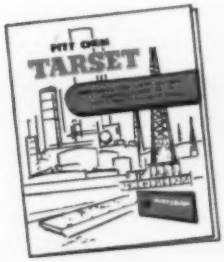


THE Huntington Lake power dams in Central California have performed yeoman service since their construction in 1917. But 38 winters in the High Sierra is a long time . . . long enough for the annual freezing and thawing cycles to react on the concrete surfaces of the dams' faces. Southern California Edison Company therefore took important maintenance measures last summer.

To provide maximum protection against corrosion, welded steel plates—behind which was poured a six-inch minimum thickness of concrete—were installed on the upstream faces of the two dams. The steel plates were then sandblasted and given a protective coating of Pitt Chem "Tarset," the new coal tar-epoxy resin coating.

Tarset, the toughest, hardest coating of its kind ever developed from coal tar, is being called upon to solve all sorts of corrosion problems formerly classified as "impossible." Tests show that Pitt Chem Tarset can stop corrosion caused by atmospheric exposure . . . sour crude petroleum and petroleum products . . . salts and acids. And it actually becomes harder at temperatures as high as 400°F!

What can Tarset do for you? Outline your corrosion problem—either by phone or letter—and we'll gladly help you solve it.



Send for Descriptive Booklet on TARSET today

Free booklet tells how to use amazing new Tarset to reduce costly corrosion. Gives detailed description of Tarset's specifications, properties and application characteristics. Write for *your* copy today!

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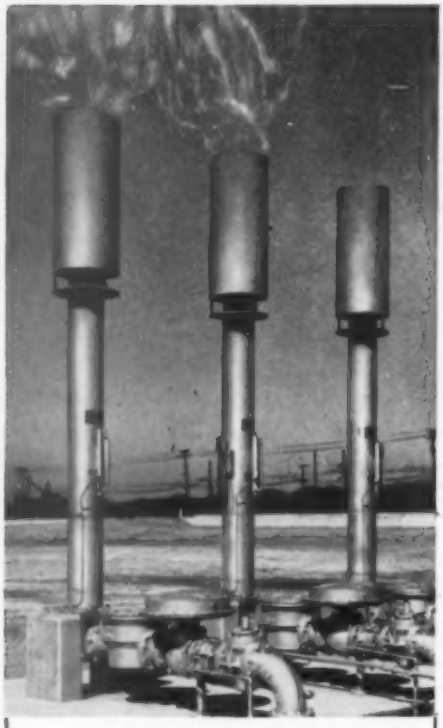
In the East Bay Municipal Utility District plant at Oakland, California . . .



The P.F.T. Waste Gas Burner consists of a baffled burner pot mounted on top of an insulated pedestal. Burner pots are provided with adequate baffled air inlets to permit continuous operation of a gas pilot and provide for intermittent combustion of excess gas through a wide range of flows. The insulated pedestal minimizes formation of condensate and prevents freezing.

excess gas is safely burned with P. F. T. WASTE GAS BURNERS

At this plant serving communities in the Bay area, three 95 ft. diameter digesters produce more gas than is needed for digester heating. To avoid resulting odor nuisance, East Bay's engineers have had three P.F.T. 6" Waste Gas Burners installed for safe, convenient elimination of excess gas.

For control and protection, each burner is equipped with a P.F.T 4" Pressure Relief Waste Gas Flame Trap, completely eliminating hazards.

In addition to this gas safety equipment, the following P.F.T. products are installed in the plant: 3 Floating Covers for the 95' digesters; 3 Heater and Heat Exchanger Units (1,200,000 B.T.U./hr.); 3 Cover Position Indicators; miscellaneous gas control equipment.

Complete information and diagram of P.F.T. Gas Safety Equipment upon request—Bulletin 321.

Design of plant by / Engineers of East Bay Municipal Utility District

P.F.T.

waste treatment equipment exclusively since 1893

PACIFIC FLUSH TANK CO.

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Chicago 13, Illinois

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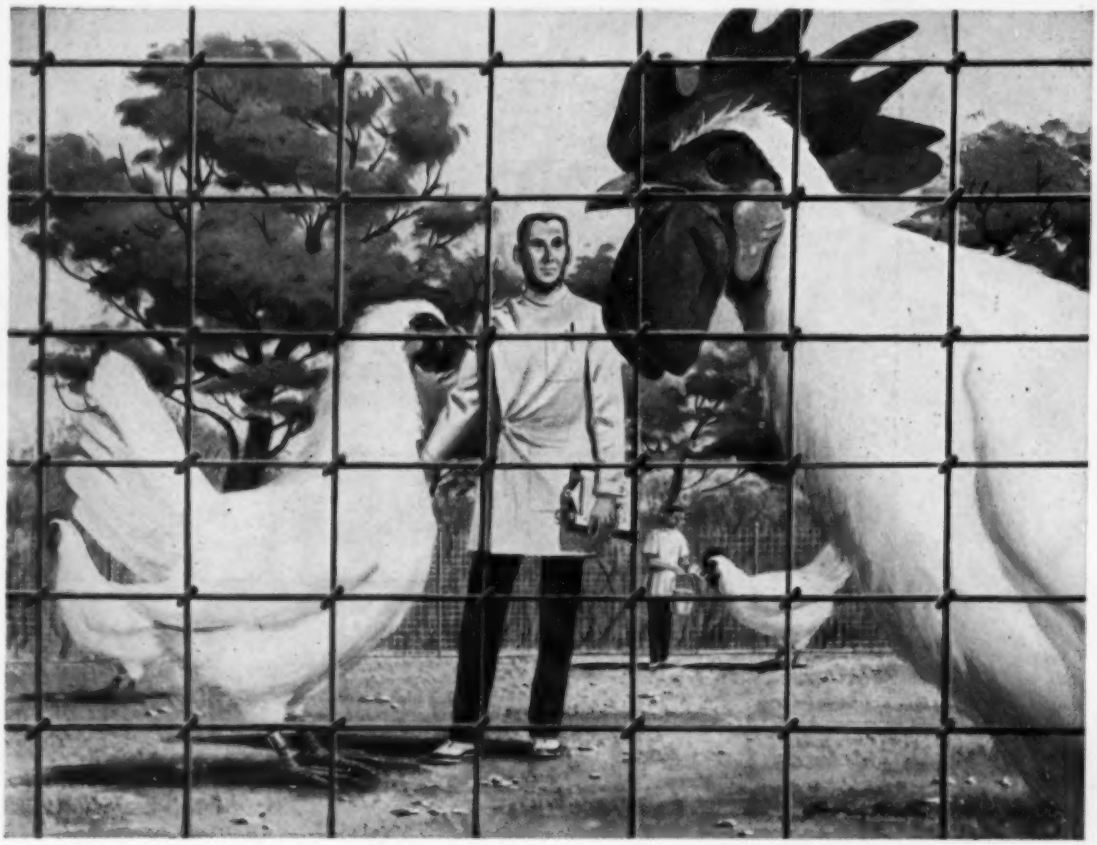

By changing the character of hormones and genes science may increase tremendously the size of fowl and domestic animals . . . put more meat at less cost on the American table.

100 years from now...

WE MAY RAISE CHICKENS AS BIG AS OSTRICHES!

How will we live, eat, travel in the future? Even scientists must include some guesswork in their predictions of the marvelous things to come. But one thing seems certain—water and gas will still be carried by the dependable, long-lasting cast iron pipe laid today. Here's proof! More than sixty American cities are still being served by cast iron water and gas mains over a century old. And today's modernized U. S. Pipe...centrifugally cast, quality controlled...is even stronger, tougher, and more durable.

U. S. Pipe is proud to be one of the leaders in a forward-looking industry whose service to the world is measured in centuries.

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FOR WATER, GAS, SEWERAGE AND INDUSTRIAL SERVICE
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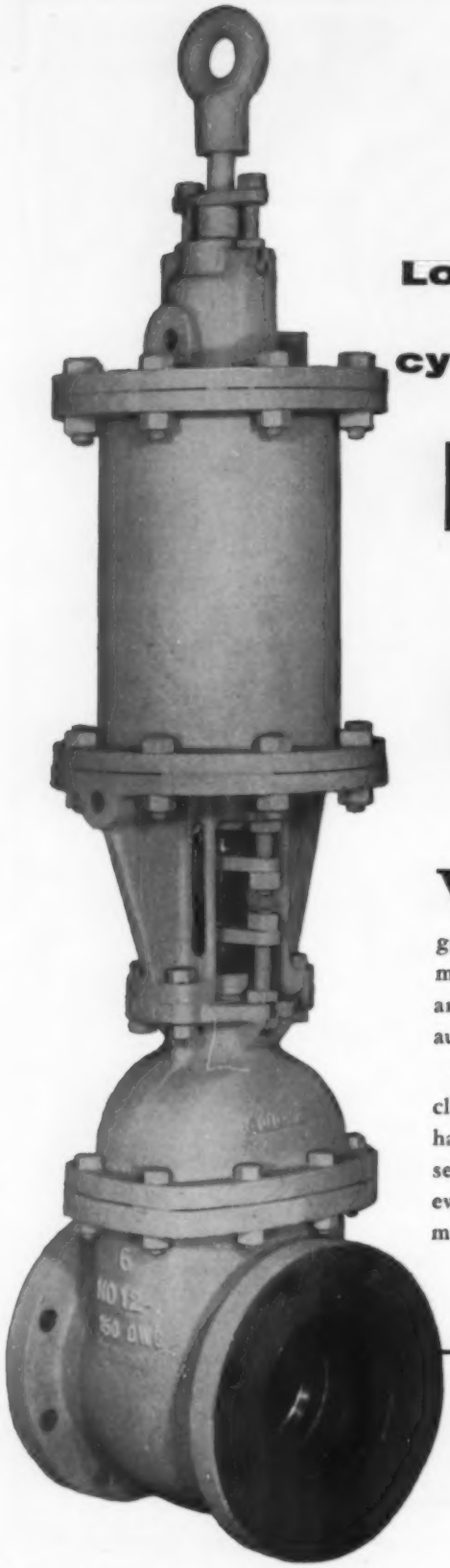
U. S. PIPE AND FOUNDRY COMPANY, General Office: Birmingham 2, Alabama

A WHOLLY INTEGRATED PRODUCER FROM MINES AND BLAST FURNACES TO FINISHED PIPE.



TRADE DARLING MARK

Look how this cylinder-operated gate valve

...SAVES TIME

...AVOIDS TROUBLE

...CUTS MAINTENANCE

WHERE frequent operation is required... especially in inaccessible locations... Darling cylinder-operated gate valves save time on each cycle of operation. The valve may be operated by air, oil or water. Movement is precise and completely controllable. Action can be either manual or automatic. Control can be either local or remote or both.

Darling's double disc gate valve principle assures tighter closing and longer, service-free life. The fully revolving discs have a wiping action that keeps seat faces clean. The discs seat in a different position with each cycle so that wear is evenly distributed. Available in a broad range of sizes and materials. Write for complete details.

DARLING VALVE & MANUFACTURING CO.

Williamsport 11, Pa.

Manufactured in Canada by Sandilands Valve Manufacturing Co., Ltd., Galt 19, Ontario

ANHYDROUS FERRIC CHLORIDE SIMPLIFIES COAGULATION

Concentrated, economical Ferric Chloride by Pennsalt is achieving wider and wider use in large and small sewage-disposal systems.

- It speeds vacuum filtration, eases filter loads, increases filter capacity.
- Its superior flocculating action produces drier, easier-to-handle cakes.

WRITE FOR TECHNICAL BULLETIN on Pennsalt Anhydrous Ferric Chloride. Industrial Chemicals Division, Pennsylvania Salt Manufacturing Company, Three Penn Center Plaza, Philadelphia 2, Pa.

OTHER CHEMICALS SUPPLIED BY PENNSALT FOR WATER AND SEWAGE TREATMENT INCLUDE CHLORINE • ALUM • LIQUID FERRIC CHLORIDE • PERCHLORON ® • AMMONIA

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NO ONE KNOWS America's water problem better than you.

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Many of you not only must find new sources of water but new ways to conserve your present supply. This calls for the cooperation of an informed and alert public, conscious of your problem and mentally conditioned to help you solve it.

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squeeze is on!

Here, we can and will continue to help.

Our national campaign, reaching millions, stresses the increasing need for industry and homeowner alike to use water wisely and plan in advance for adequate water facilities. It urges realistic water rates and asks support for the forward-looking legislation and bond issues that will insure a plentiful supply for the future.

It's designed to help America conserve its most precious national resource . . . and keep water flowing, freely and abundantly, for all.

CAST IRON . . . the pipe that's bought on proof, not claims

No other pipe can point to so convincing a record of long life.

For over 70 public utilities in America, cast iron mains laid over a century ago are still giving satisfactory service. This demonstrated record of long life (made in the ground, not printed claims) not only gives the public the dependability it has a right to expect in a water system . . . it saves tax dollars as well. Once in the ground, cast iron serves for generations with minimum maintenance. Cast iron's long term economy pays off!

Today, water officials can rely on even better cast iron pipe. Modernized cast iron, centrifugally cast to be even tougher, stronger, more uniform. And where needed and specified, lined with cement mortar to assure sustained carrying capacity throughout its long service.

You specify wisely and well when you specify cast iron pipe for your water system. The experience of centuries proves you chose the best.

Cast Iron Pipe Research Association, Thomas F. Wolfe, Managing Director, 122 So. Michigan Ave., Chicago 3, Ill.

This gallant old cast iron water main laid in 1850 is still serving and saving tax dollars for the citizens of Buffalo, N. Y.

CAST Q IRON ®

The Q-Check stencilled on pipe is the Registered Service Mark of the Cast Iron Pipe Research Association.

pipe FOR MODERN WATER WORKS

Tough Problem Solved

F&P Engineering solves Meyersville's problem: Higher fire insurance rates or safe water.

If all the property owners in Meyersville, Maryland were to avoid an increase in fire insurance rates, the main water pressure, during fire emergency, had to be maintained above the allowable minimum.

All other automatic proportioning Chlorinator systems recommended to Meyersville required permanent head losses far in excess of the allowable minimum or were prohibitively expensive.

All, that is, except the F&P Chlorinator. F&P, applying its wide instrumentation and systems engineering experience, utilized standard components to solve Meyersville's problem.

Since its installation the F&P unit has given accurate, maintenance-free, money-saving service.

If you have *any kind* of chlorination problem, why don't you call Fischer & Porter now? Write or call today—without obligation—for complete information and engineering data.

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216 FISCHER ROAD, HATBORO, PA.

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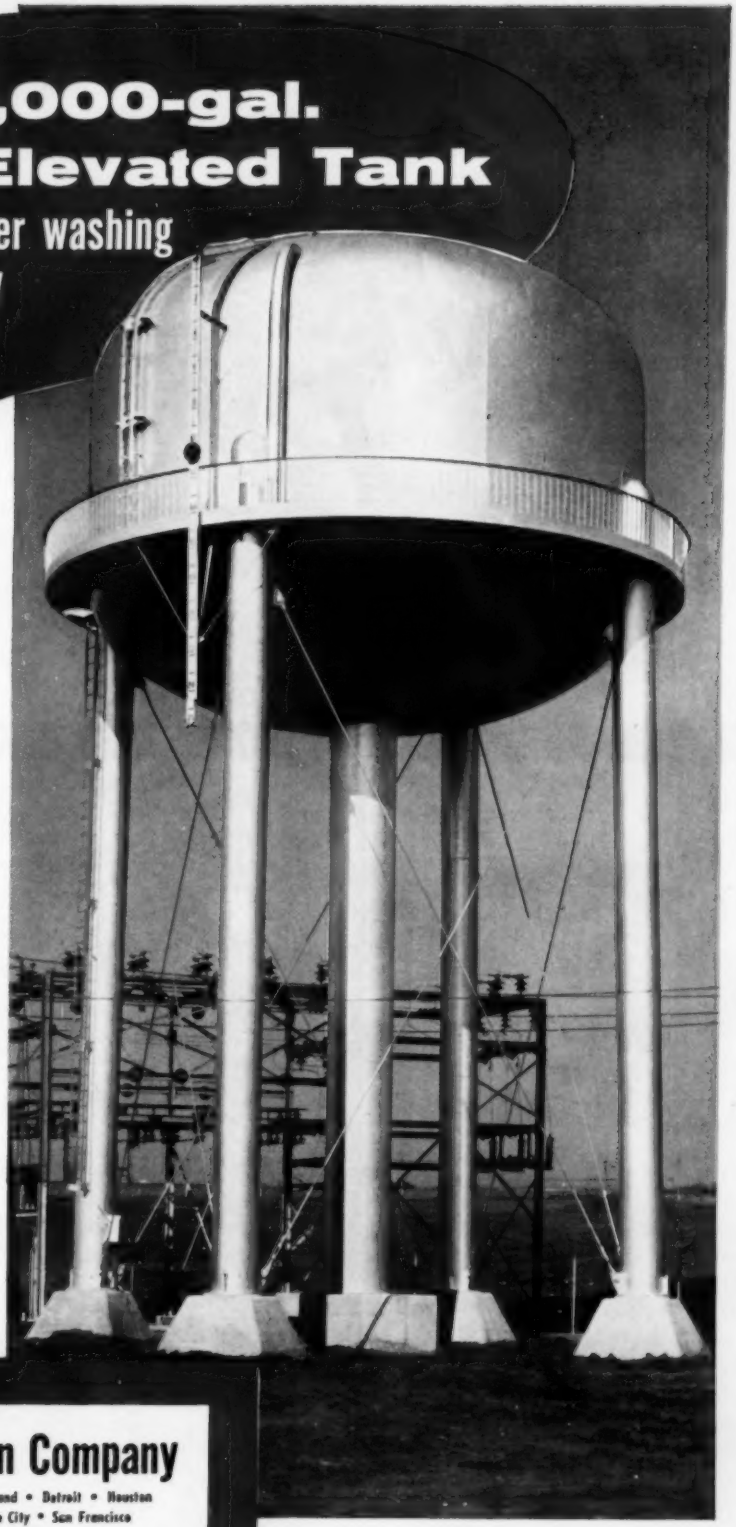
LA1113

150,000-gal. Horton Elevated Tank

proves ideal for filter washing at Oklahoma City Filtration Plant



This 150,000 gallon Horton® ellipsoidal-bottom elevated tank, provides the Oklahoma City, Oklahoma, filtration plant with the large quantity of water and steady, dependable gravity pressure necessary for efficient filter washing. Ideal for filter washing, Horton tanks are available in the capacity and head required to meet filtration plant requirements.

Horton elevated tanks for municipal service are built in capacities to 3,000,000 gallons. When you plan wash water tanks or additional storage capacity for your municipal water system, write our nearest office for help, information or questions.

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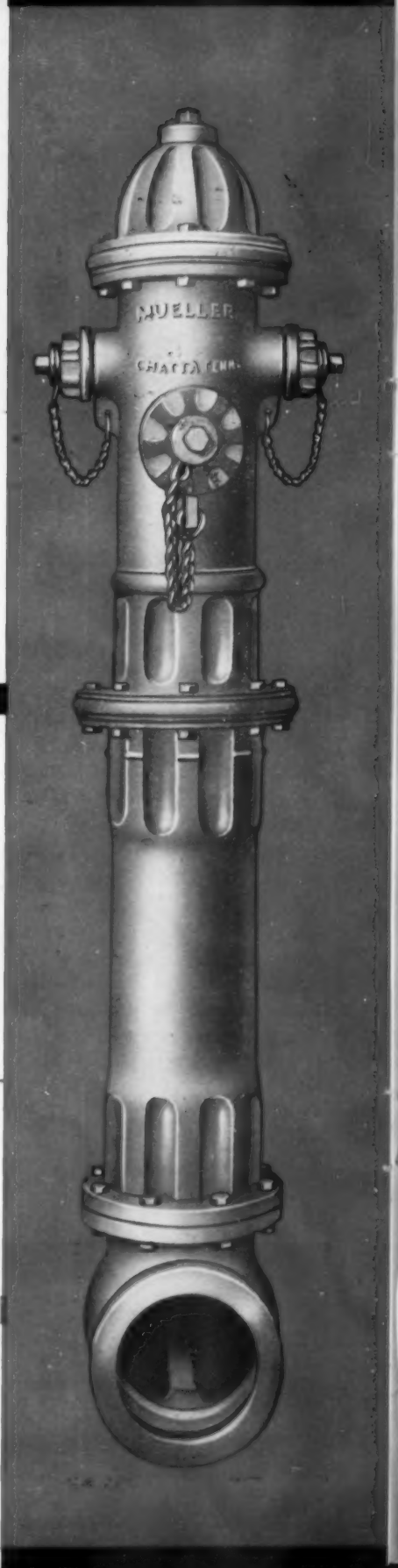
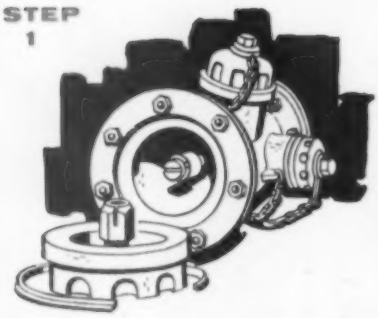


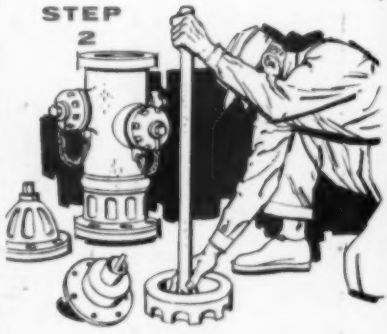
FOLLOW THESE SIMPLE STEPS

STEP 1



Remove broken safety flange from upper barrel section of hydrant. Remove damaged stem coupling and sleeve. Remove bonnet assembly, stuffing box and stem from upper barrel. (NOTE: Before sliding stem out of stuffing box, slip A-24099 brass sleeve over threads to prevent "O" ring damage.)

STEP 2



Screw new safety stem coupling down against shoulder on lower stem. Slip safety sleeve over lower end of upper stem section. Screw upper stem into safety stem coupling until it bottoms against lower stem.

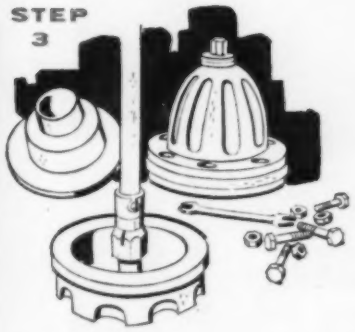
Contact your Mueller Representative or write direct for complete details.

MUELLER®
improved fire hydrant

Designed to withstand the most adverse weather conditions, the Mueller AWWA Improved Fire Hydrant is ready for instant use for emergencies.
Large bronze weather cap prevents freezing of operating nut.
Dry top design keeps water away from threads and bearing surfaces.
"O" ring stem seals provide perfect watertight seal and hold oil in reservoir, keeping threads lubricated. Safety stem coupling and flange provide simple, fast repair in case of traffic damage.
Above ground maintenance makes it a simple matter to keep the Mueller Improved Fire Hydrant in an "always ready" condition.

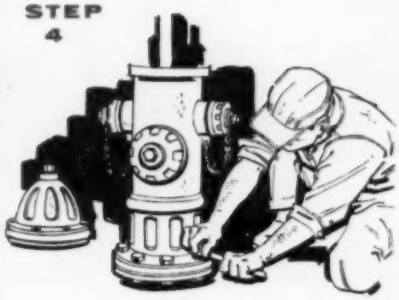
FOR REPAIR AFTER TRAFFIC DAMAGE

STEP 3



Align slot in safety stem coupling with tongue and groove in stems. Screw coupling upward until tongue and groove of stems lock firmly together. Drop safety sleeve down over upper end of coupling and tighten setscrew in sleeve.

STEP 4



Install flange gasket on lower barrel – position upper barrel making sure gasket remains centered. Bolt the two halves of the safety flange in place with circular groove facing upward. Make sure safety flange fits lower barrel snugly.

STEP 5

Slide stuffing box over brass sleeve on stem threads. Position stuffing box plate and bolt to barrel. Remove brass sleeve. Fill oil reservoir and replace bonnet. Turn operating nut clockwise to engage stem. Position filler plug over oil reservoir and bolt bonnet to barrel. Repair is now complete.

MUELLER CO.

Dependable Since 1857

MAIN OFFICE & FACTORY DECATUR, ILLINOIS

Palatable Water Is Your City's Best Salesman

The quickest way to be beseiged with complaints is to allow odorous water to get through to your consumers. Such occurrences can be prevented by adequate dosages of AQUA NUCHAR, activated carbon. Odor concentrations can be controlled within palatable limits by running periodic Threshold Odor tests throughout the day, and varying the carbon dosage accordingly.

Our technical staff will gladly, without obligation, give your plant a complete odor survey and recommend how and where AQUA NUCHAR can best be used to produce palatable water.

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Water Departments that buy American Frost Bottom Meters have no worries. They know that the breaking pressure of the bottom has been predetermined at the factory and since it breaks by tension and not by shearing it is unaffected by flange bolt tightness. Breaking of bottom permits all internal parts including gear train parts to separate without damage. A new inexpensive Frost Bottom can be attached in a few minutes. It's as simple as that. So, let freezing weather come. You haven't a worry when you buy American!

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Another 1,500,000
gallons of "certain-sure"
water service for
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LONG ISLAND, N. Y.

1951

Elevated Steel Tanks by

PITTSBURGH-DES MOINES

Latest of the many PDM Elevated Steel Tanks towering over Long Island's level terrain is this 1,500,000-gallon Radial Cone installation for Hempstead. 88 ft in diameter, the tank has a headrange of 35 ft and is on a tower 135 ft to bottom of capacity. Shown at right is an earlier million-gallon PDM tank of the same design, built for Hempstead in 1951.

● Write for our new Modern Water Storage Catalog.

PITTSBURGH • DES MOINES STEEL CO.

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PDM
ELEVATED STEEL TANKS

DAILY TIMES

WATER USE UP 75% BY 1975!

Competition for water mounts
...ong public and industrial
... and ...

Today make sure your community can meet everyone's demands tomorrow

With the water situation already critical in many localities — and competition for water mounting alarmingly among all classes of users — conservation may well be "Operation Survival" for your community. And the first logical step is to set up an accounting of all residential and industrial water use — with Badger Meters.

This precise check sharply reduces water waste, cuts water plant power costs, establishes a fair sharing of water for all, and invariably increases water department revenue... a sound investment in the future.

How critical is the situation? The U. S. Department of Commerce forecasts an increased water demand of 75% by 1975. And the dwindling supply of water could certainly be an acute problem *long before then.*

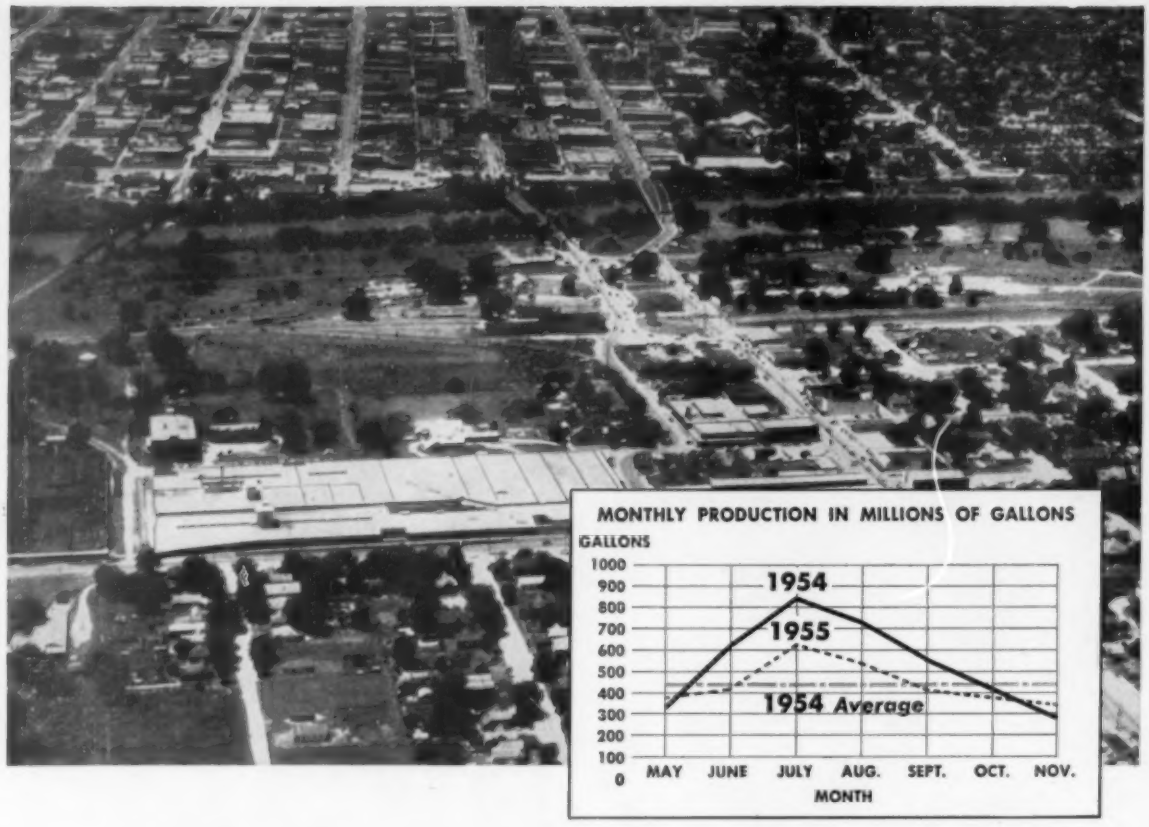
So make the first strategic move *now.* Let us send you comprehensive literature and, if you wish, set up an appointment with the Badger Meter representative in your area. He will gladly discuss your water problems and furnish complete data on the meters best suited to your community's needs.

Write us today, without obligation.

Badger Meters have conserved it for 50 years

Badger Water Meters

BADGER METER MFG. CO. • Milwaukee 45, Wisconsin



ALOXITE® underdrains handle double load without difficulty in Waco, Texas

Peak loads during dry spells really tax Waco's water system. At these times the filters handle up to 4 GPM per sq. ft.

In July, 1954, for instance, water consumption jumped from the year's average of 448 MG to 842 MG per month. Despite this 87% increase in demand there were no operating difficulties.

Much credit for being able to meet such abnormal requirements is given to the ALOXITE® aluminum oxide porous underdrains. These were installed in new filters in 1951.

Since then, several related events have occurred. Population has grown from 84,000 to 110,000. Water consumption has reached 14.7 MGD from 10.0 MGD. And mudballs and upset beds are but a memory for the plant operators. Uniform, ample backwashing is now an established and vital phase of operation.

The City of Waco is to be commended for its foresight in providing equipment to assure adequate water supply, even during peak demand periods. Mr. Curtis Harlin is Superintendent of Water and Sewage, while Mr. W. J. Biederman is Plant Superintendent. J. J. Rady Company, Fort Worth, Texas were Consulting Engineers.

Answer your questions about porous media with this informative 56 page booklet. It's yours for the asking. Just write to the address below.

CARBORUNDUM

Registered Trade Mark

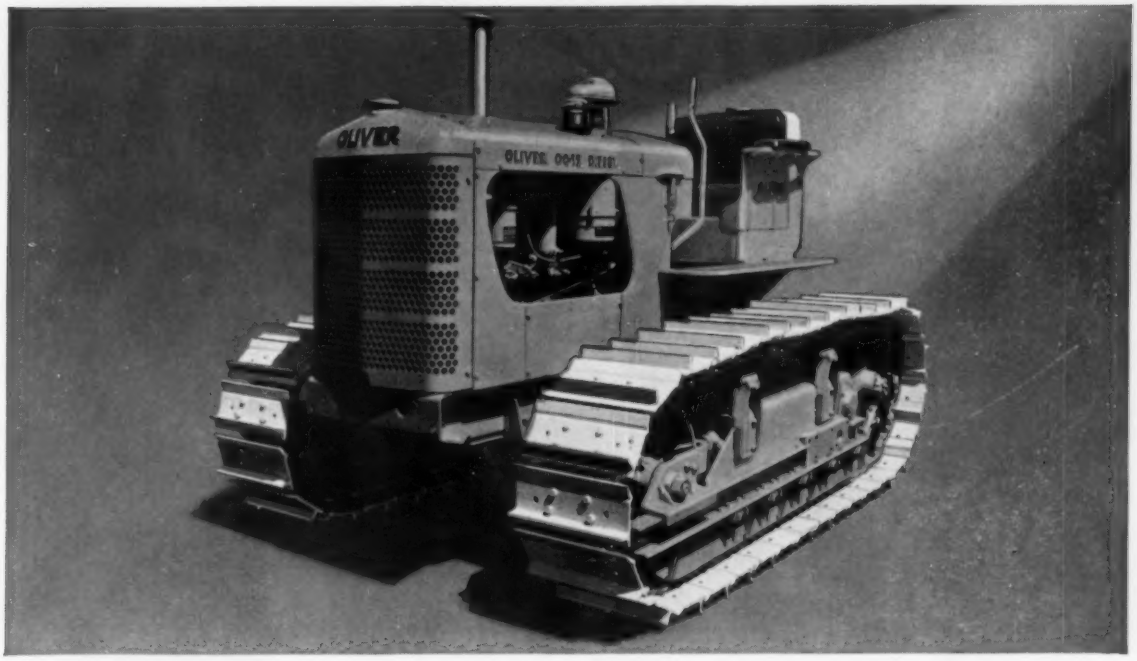
Dept. X116, Refractories Division

The Carborundum Company, Perth Amboy, New Jersey

IT'S READY!

...THIS FINE NEW OLIVER OC-12

WITH POWER-TURN STEERING



Still easier to handle...more versatile than ever!

The OC-12 is the ideal machine for digging basements, etc., where easy maneuvering and big capacity mean lowest cost. A 30° bucket rollback insures a full load at every pass—and with less spillage. The OC-12 is available with a full complement of attachments including loader, dozer, trail-builder, scarifier, winch, etc.

Now, with many new improvements, this popular OC-12 becomes even more outstanding for sheer performance, sheer value. Here are features that let you do more work for less money on your whole range of jobs.

Power-Turn Steering gives you two independent, yet connected, systems of speed control—one for each track. You make sharper turns in the tight spots... gradual turns at *any* angle... and always with power on *both* tracks. It's more efficient on *every* move.

New over-center hand clutch gives you easier, faster, smoother shifts. It's 33⅓% larger for more positive engagement—longer lasting, too. And you *can't* ride *this* clutch!

New foot brake lets you hold the tractor easily on any grade, leaves hands free for operating other controls.

High torque diesel engine gives you over 53 drawbar h.p.—steady, dependable power—with the extra "oomph" for the most severe demands.

Your Oliver distributor is ready, too! Ask him to demonstrate. Get into the driver's seat and see the difference—on your own jobs!

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400 West Madison Street, Chicago 6, Illinois

OLIVER

A COMPLETE LINE OF INDUSTRIAL WHEEL AND CRAWLER TRACTORS AND MATCHED ALLIED EQUIPMENT

"... it appears ... that brine regeneration of the zeolite does not remove all of the iron from the zeolite ... this results in a gradual decrease of the exchange capacity of the zeolites, which may drop to as low as one-third of the original exchange capacity. ... Sodium hydrosulfite will sometimes reduce the iron and allow its removal with salt regeneration. Treatment of the zeolite with 10 per cent HCl, followed by salt regeneration, may return the zeolite to its original capacity, but these measures are not preventative. It has been shown, however, that proper dosage of polyphosphates in the raw water will prevent retention of iron and fouling of the beds by iron retention."

from "Report on the Effect of Iron on High-Capacity Zeolite"
by Edgar G. Will, Page 739, Journal AWWA—June, 1956.

WHY WASTE TWO-THIRDS OF YOUR SOFTENER CAPACITY?

Stop iron fouling of zeolite beds with CALGON®

The recent article quoted above provides independent laboratory proof of the anti-iron-fouling abilities of polyphosphates.

This ability to maintain maximum capacity by preventing iron retention and iron fouling of zeolites has long been recognized by Calgon chemists. In fact, Calgon* brand sodium hexametaphosphate is the most effective and the most widely used polyphosphate for the stabilization of iron and iron compounds.

Pretreatment of iron bearing waters with threshold amounts of Calgon is the most economical and effective way of preventing the fouling of zeolite beds by iron retention and keeping softener capacities at high efficiency.

If you are softening water which contains iron compounds, Calgon water treatment chemists will be glad to work with you. Write for full information on what Calgon can do for you.

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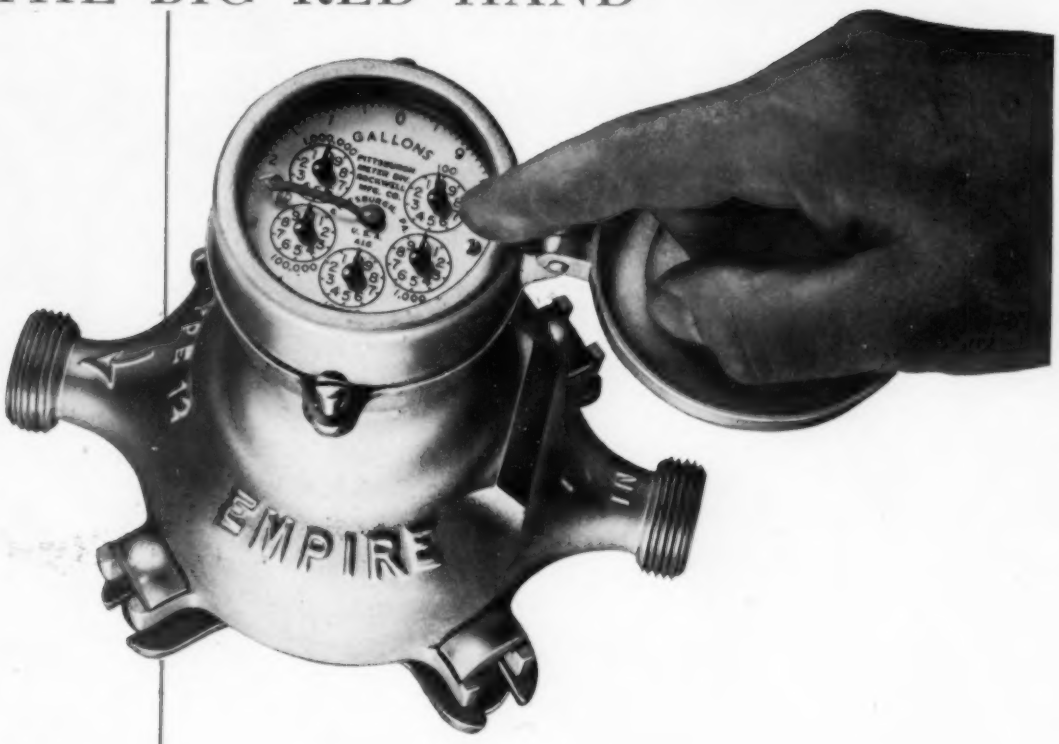
A Subsidiary of Hagan Corporation, Hagan Building, Pittsburgh 30, Pa.

*Calgon brand sodium hexametaphosphate is fully licensed under U. S. Patent No. 2,304,850 covering such applications.

THE BIG RED HAND



Another Bonus Value In All Rockwell Water Meters

As *standard construction* the registers on all Rockwell meters have a large red center test hand. This red hand sweeps the entire outer circumference of the dial. Like the split-second hand on a stop watch, the slightest movement can be seen.

When testing a new or repaired meter, this large hand and big circle scale provide a much closer accuracy check than can be obtained from a conventional small test hand. Center mounting permits a better arrangement of the dial—one that's easier to read. And the large sweep dial test hand is an invaluable aid when checking for leaks on customer's premises.

The big red hand is only one of the bigger, better values that Rockwell builds into all its water meters. It's an outward indication of *quality* construction through and through. *Write for catalogs.*

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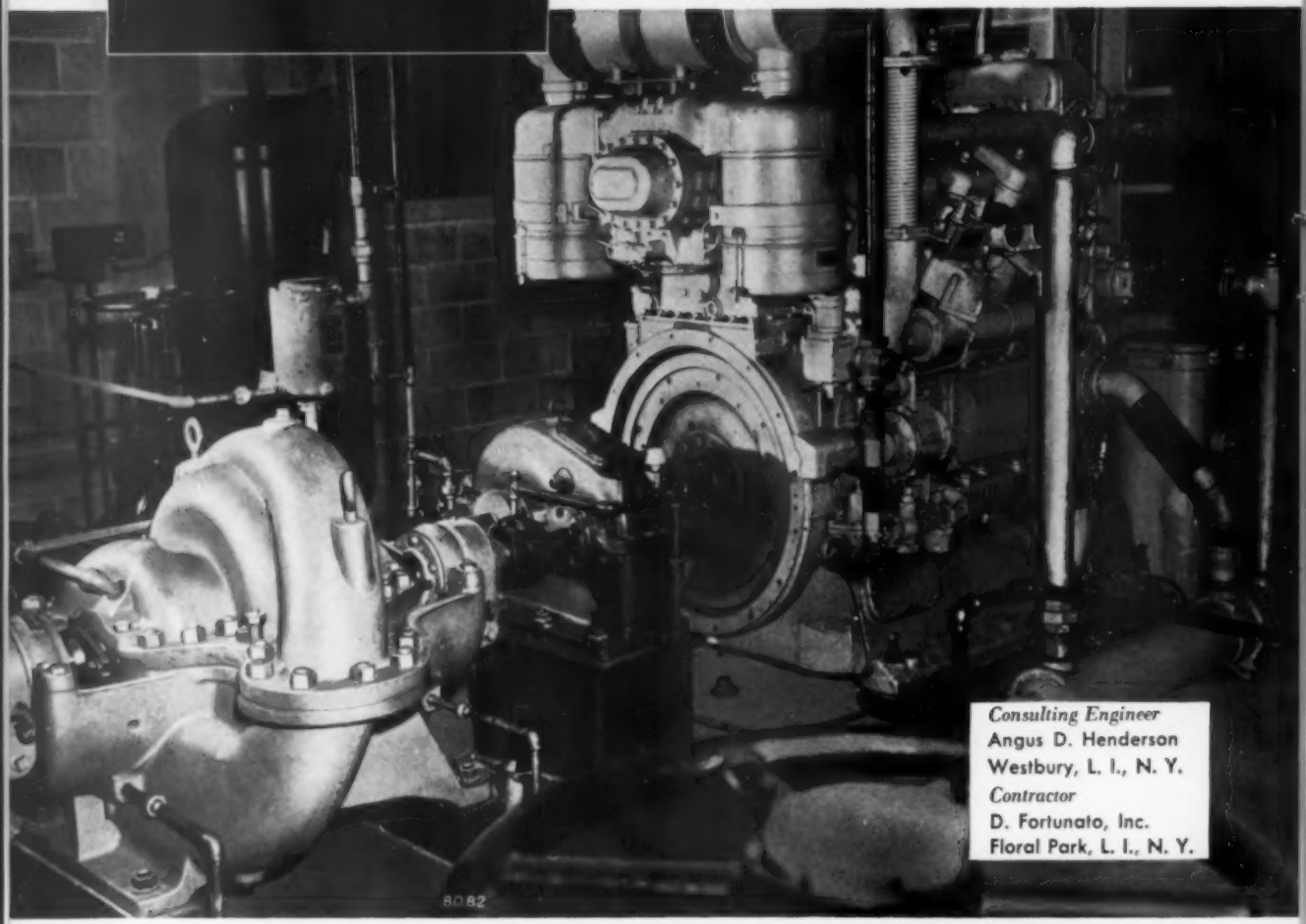
ROCKWELL WATER METERS

A Size and Type For Every Kind of Service

DE LAVAL
TWO-STAGE CENTRIFUGAL PUMPS

boost pressure at peak loads in Port Washington, New York



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Angus D. Henderson
Westbury, L. I., N. Y.
Contractor
D. Fortunato, Inc.
Floral Park, L. I., N. Y.

This De Laval two-stage horizontal split-case pump is one of a pair used to boost pressure during peak hours in the Port Washington, New York water works. Taking water from a large underground storage tank, these De Laval units maintain pressure throughout the system. The dependable centrifugal pumps are powered by Caterpillar diesels with speed increasers; they deliver 1500 gpm at 400 feet tdh with 15 feet lift requiring 185 bhp.

De Laval 2IS-2KS pumps are designed with • back-to-back impellers for balanced hydraulic thrust • easily replaceable threaded impeller wearing rings • long-life labyrinth case rings • ring-oiled ball bearings—plus ten other important design features. They are available in sizes from 2 inch to 8 inch discharge, for capacities to 3000 gpm and heads to 750 feet. *Write for Bulletin 1501 giving complete data.*

Readers of this publication can obtain the De Laval Engineering Handbook (Regular Price $3.00) for one dollar. Its 336 pages contain mathematical, mechanical, fluid and other data on turbines, pumps, compressors and reduction gearing. Write for your copy.

DE LAVAL *Centrifugal Pumps*

DE LAVAL STEAM TURBINE COMPANY

Nottingham Way, Trenton 2, New Jersey

DL 937

HERSEY

Two very important factors in the success of any water meter are accurate registration, to insure full compensation for water delivered, and low maintenance cost to keep the overhead down. These are but two of the advantages you get by using

HERSEY WATER METERS

HERSEY MANUFACTURING COMPANY

SOUTH BOSTON, MASS.

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In Every Price Bid . . .
"There is hardly anything in the world that some man cannot make a little worse and sell a little cheaper"
—Ruskin
TRIDENT

there's a cost that stays *Sealed* for seven years

All water meters are fine instruments. Any fine instrument loses accuracy as it wears. Because of this fact, written between the lines of any water meter price are two items you can't read for many years. Yet they are vital in choosing the lowest "total price."

First, as a meter loses accuracy, it gives away revenue. Before its first overhaul it may give away twice as much money as it seems to save in its "low bid" original price.

Secondly, to keep the meter accurate you may have higher repair costs over the years . . . or premature scrap-and-replace costs. Good meters often vary widely in this respect.

Tridents are preferred because they earn more and cost less in the long run. They never become obsolete. You modernize your Tridents as you repair. Ask your neighbor . . . or ask Neptune for details.

275

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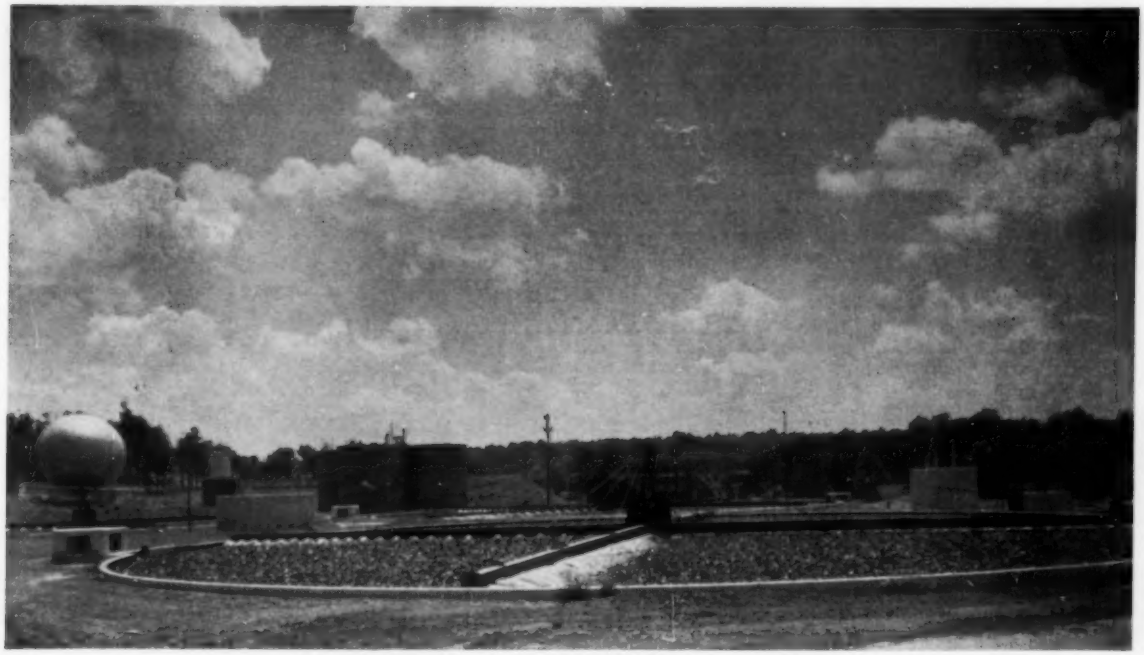
WATER & SEWAGE WORKS

VOL. 103, NO. 11 • A Scranton Gillette Publication • NOVEMBER, 1956



CHARLOTTE'S newest 10 mgd treatment plant—Irwin Creek

Charlotte's Newest Sewage Treatment Plant

Designed to treat a combination of sewage and industrial wastes in shock-loading proportions.

by GEORGE S. RAWLINS and THOMAS H. TASSOS.
Mr. Rawlins is vice-president of J. N. Pease and Company, consulting engineers and architects of Charlotte, N. C.
Mr. Tassos served as resident engineer for J. N. Pease & Co. on the Charlotte project, after having been connected with the design of the plant.

WITH the completion of the rebuilding and expansion of the Irwin Creek Sewage Treatment Plant in July, 1956, Charlotte, North Carolina, now has two new plants which treat a combination of domestic and industrial waste with excellent results. The Sugar Creek Sewage Treatment Plant, serving another Charlotte watershed, was completed in 1955.

The design of the new bio-activated sludge plant at Irwin Creek was based on a 24-hour average flow rate of 10 MGD with a peak rate of 20 MGD. In Table 1 of this article is recorded the data upon which the plant was designed.

BATTERY of six F-M raw sewage pumps.

SLUDGE concentration tanks (Laboon Process)

Plant Description

The raw sewage enters the plant at a structure that forms two separate channels, each equipped with a "Barminutor" unit. Two of these screening comminutors are used to give greater flexibility of operation in that one or both may be in service, as the flow may warrant. From this point the flow is to the pre-aeration basins which separate and remove the grit and grease and pre-aerate the influent. The grit is collected in hoppers in the floor of the basin and is removed from these hoppers by means of a three-stage air lift.

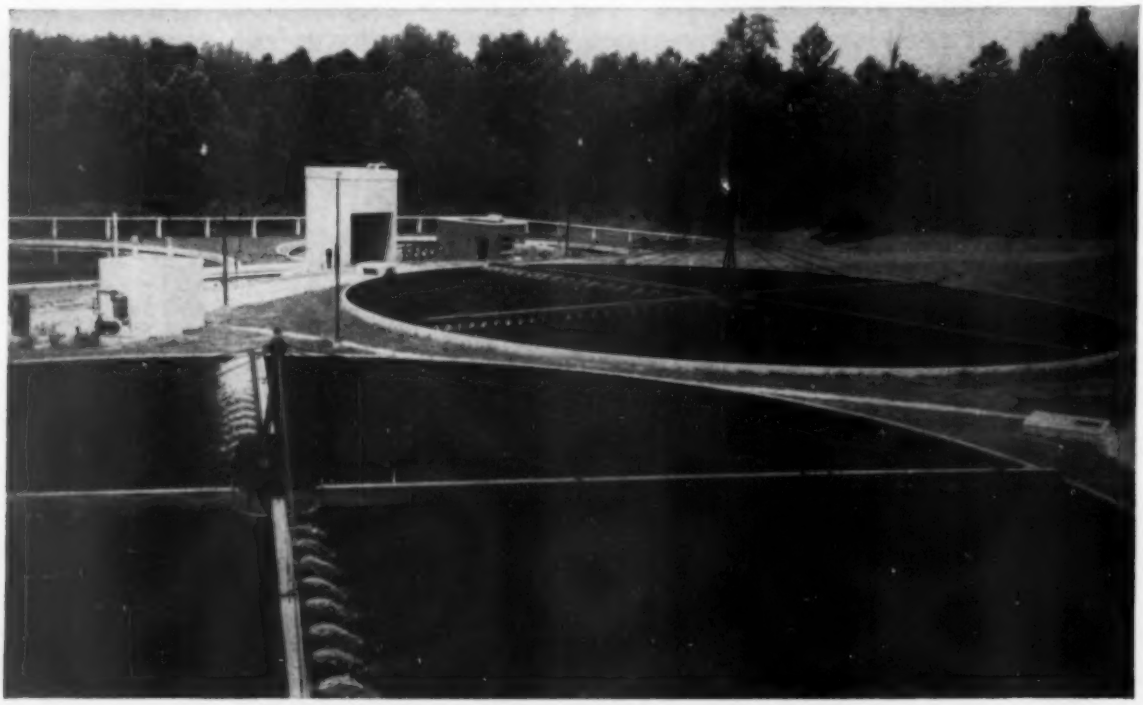
TABLE I
Basic Design Data

1. Contributing Population (1950)	62,000*
2. Contributing Population (1964)	80,000*
3. Equivalent Population (1964)	245,000* (*Estimated)
4. Sewage Flow Rates for Design Purposes	
(a) 24 Hour Average Day	10.0 MGD
(b) 24 Hour Maximum Day	12.7 MGD
(c) Max. 8 Hour (Avg. Day)	13.3 MGD
(d) Max. 4 Hour (Avg. Day)	13.6 MGD
(e) Peak	20.0 MGD
5. Sewage Characteristics for Design Purposes	
(a) BOD	500 ppm*
(b) Suspended Solids	230 ppm

(*BOD loading—41,650 lbs/day)

Immediately below the grit chambers are two 24" Parshall Flumes (No. 1 and No. 2). Parshall Flume No. 2 measures the flow to Primary Clarifier No. 3 or to the raw sewage storage tank, later to be described. Flume No. 1 measures the flow to Primary Clarifiers No. 1 and No. 2. The design overflow rate for the clarifiers is 800 gallons per square foot per day. The detention time is two hours at the average daily rate.

The effluent from the two 125-foot diameter primary clarifiers flows by gravity to six sewage lift pumps,



ROUGHING filters absorb shock loads ahead of activated sludge

WELL equipped laboratory.

which are automatically operated by float controls located in the pump suction wet well. The pumps lift the sewage to a distribution manhole which divides the flow evenly to three 125-foot diameter roughing trickling filters. The filters have a depth of stone of four feet and two inches, placed over clay tile underdrains. The primary purpose of these roughing filters is to absorb the shock loads created by industrial waste. After leaving the filters the sewage enters a recirculation manhole where the recirculation rate is controlled at 10.0 MGD at minimum influent flow of 2.4 MGD to the maximum four hour flow of 13.6 MGD. From this maximum flow the recirculation rate is gradually reduced to 5 MGD at the peak flow of 20 MGD. (See Table 2).

TABLE 2
Trickling Filter Dosage

Influent	Recirculation Rates	MGAD
2.4 MGD (Min. Flow)	10.0 MGD	14.7
10.0 MGD (Avg. 24 hr.)	10.0 MGD	23.7
12.7 MGD (Max. 24 hr.)	10.0 MGD	26.9
13.3 MGD (Max. 8 hr.)	10.0 MGD	27.3
13.6 MGD (Max. 4 hr.)	10.0 MGD	28.0
20.0 MGD (Peak)	5.0 *	29.6

(*Recirculation reduced for high flows)

The remaining effluent from the roughing filters flows to a control basin that proportions the sewage flow to two additional 24" Parshall Flumes (No. 3 and No. 4). Flume No. 3 measures the quantity of sewage flowing to the original aeration tanks serving the old plant that have been reconditioned. Flume No. 4 measures the flow to the new aeration tanks. The detention time at the average rate of 10 MGD, including 40% return sludge at the average rate, is eight hours. Greater flexibility of treatment is afforded in that the old aeration tanks may be used as sludge nitrification tanks, using the

AERATION tanks—old and new. Beyond is old laboratory converted to chlorination station.

Kraus Interchange Process of sludge feeding and aeration.

The design average air requirement is one cubic foot of air for each gallon of sewage. However, the total installed air compressor capacity is three cubic feet per gallon of sewage at the design flow of 10 MGD. Air for the tanks is received from one or more of four new variable speed controlled blowers and one old reconditioned blower. These blowers are housed in the old renovated compressor building.

After aeration the sewage enters two 100-foot diameter secondary clarifiers with a design overflow rate of 650 gallons per square foot per day and an overflow rate of 855 gallons per square foot per day during the eight hour maximum rate. From this point the effluent flows to a mixing basin where chlorine will be introduced when it becomes necessary. From results obtained for the short time the plant has been in operation, the addition of chlorine will not be required for the present. Nevertheless complete chlorination facilities are available for emergencies and the future.

Upon leaving the mixing tank the sewage flows through a chlorine contact tank having a detention time of 30 minutes at the average daily rate. From here the final effluent enters the creek after being metered.

The maximum rate of sludge return is 4 MGD. This sludge is received from hoppers at the center of the secondary clarifiers and pumped to a distribution manhole where the sludge flow is divided and quantities are measured by means of five V-notch weirs. From this structure the sludge is returned to the aeration tanks or wasted to the primary clarifiers.

Contractors

General Construction	Rea Construction Company
Furnishing Air Compressors	Chicago Pump Company, Inc.
Furnishing Pumping Units and Controls	Fairbanks, Morse & Company Worthington Corporation Bell and Gossett Company Purser and London, Inc.
Laboratory Furniture	Charlotte Chemical Labs., Inc.
Electrical Work	R. H. Bouligny, Inc.
Heating and Ventilating	A. Z. Price and Associates, Inc.
Plumbing Work	Toomey Brothers
Furnishing Air Diffusion Equipment	Chicago Pump Company, Inc.
Installation of Air Diffusion Equipment	L. O. Chapman Company, Inc.
Landscaping	J. Frank Harkey Nursery Jack H. Clark, Landscape Contr.

Equipment Manufacturers

Electrical Switchgear	General Electric Company
Raw Sewage Pumps	Fairbanks, Morse & Company
Raw Sludge Pumps	Marlow Pumps, Division of Bell and Gossett Company
Activated and Nitrified Sludge Pumps	Fairbanks, Morse & Company
Flushing Water and Spray Pumps	Fairbanks, Morse & Company
Miscellaneous Pumps	Chicago Pump Company
Flow Instrumentation	Builders-Providence, Inc.
Digester Floating Cover, Gas System Balancing Tank, and Sludge Concentration Tanks Heat Exchanger	Pacific Flush Tank Company
Gas Holder	Chicago Bridge and Iron Company
Automatic Sampler, Air Diffusing Equipment, Tube Washing Equipment, and Grit Removal System	Chicago Pump Company
Primary and Secondary Clarifier and Roughing Filter Equipment	Process Engineers, Inc.
"Barminutors"	Chicago Pump Company
Electrostatic Air Filters	American Air Filter Company, Inc.
Gas, High Pressure Air, and Instrument Air Compressors	Worthington Corporation
Low Pressure Air Compressors	Read-Standard Corporation
Catalytic Unit	Catalytic Combustion Corporation
Chlorinator Equipment	Wallace and Tiernan, Inc.
Scales	Fairbanks, Morse & Company
Gas Metering Equipment	Hagan Corporation
Cone Check Valves	S. Morgan Smith Company
Sluice Gates	Armco Drainage and Metal Products, Inc.
Flash Mixer	Walker Process Equipment, Inc.
Pump Priming Unit	Skidmore Corporation

Sludge Digestion

Separate sludge digestion as accomplished in this plant is conventional, with the addition of the Laboon Sludge Concentration Process. Sludge is taken from a hopper at the center of the primary clarifiers and flows to wells at the main pump building where it is pumped to the concentration tanks and then to the digesters, or directly to the digesters where and if desirable.

The sludge concentration tanks are designed to utilize the principle demonstrated by J. F. Laboon of Pittsburgh, Pa. After the first three days of anaerobic action while being stored, the solids and the liquor of the raw sludge will separate, with the solids concentrating at the top and the subnatant liquor at the bottom. The subnatant liquor is then drawn-off and returned to the plant influent. The concentrated solids remaining are pumped to the digesters for completion of the digestion.

The digestion facilities of the old Irwin Creek Sewage Plant consisted of four 65-foot diameter tanks (three with floating covers) and the necessary heat exchangers, pumps and gas equipment. Experience at this plant indicated that only approximately 16% of the total sludge is dried during the months of October to December and that practically no drying is accomplished during the January to March period. Therefore, to provide additional capacity for digestion and storage of sludge, a new cover was added to the fourth tank and two new 65-foot diameter tanks were constructed without covers.

From the digesters the sludge is delivered to the drying beds, with the supernatant liquor being returned to the inlet end of the plant. The gas generated from the digestion process is used for heating the digesters, heat-

ing the sludge concentration tanks, general plant heating and use in the laboratory.

Use of Third Clarifier for Equalization

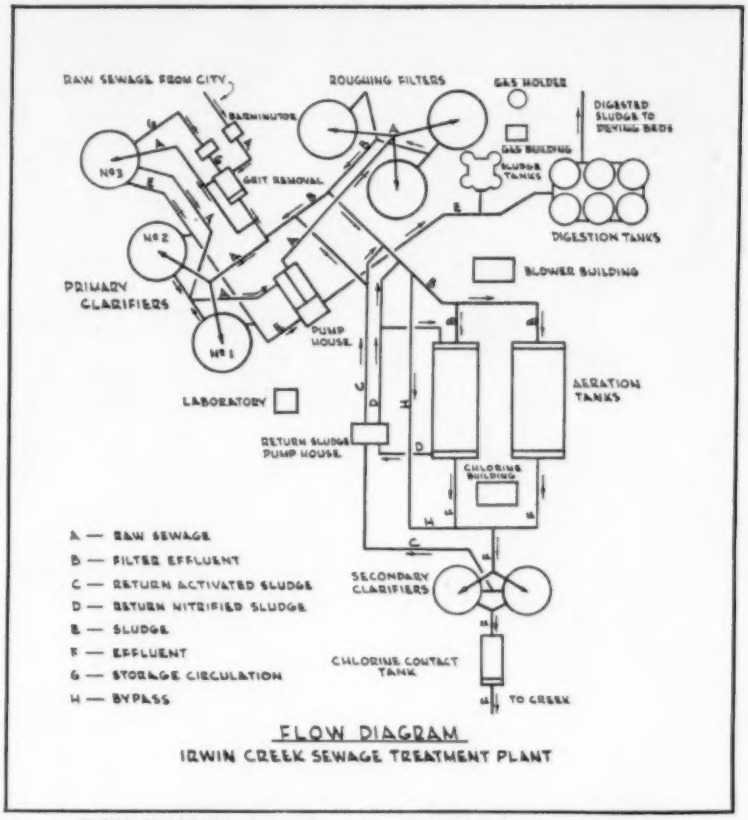
Clarifier No. 3 was designed to be operated as a supplemental primary clarifier or as a storage tank to receive peak loads for later feeding to the other plant units. There are two approaches to the problem of equalization of the treatment requirements over the average day. These are, to equalize sewage flow and oxygen demand load as nearly as possible.

"The ratio of the average maximum BOD and flow to average minimum BOD and flow is 3.8 to 1.0 and 2.8 to 1.0, respectively. On the other hand the ratio of average maximum oxygen demand to average minimum oxygen demand is 10.3 to 1. By proper diversion, temporary storage and subsequent feed back of the influent sewage to the system, these ranges can be cut to about one-half."

This diversion is accomplished by the use of a pneumatically controlled sluice gate. With an increase in flow to the plant beyond a set point, the gate will raise. With a decrease, the gate will lower thereby allowing more sewage to be diverted into the holding clarifier during high flows and less during low flows.

Because storage of sewage creates an anaerobic condition, a pumping station containing two circulating pumps and a small aeration tank allowing air to be applied to the sewage was incorporated into the design. Operation of these pumps results in the sewage being directed through the aeration tank and returned to the clarifier or to other plant units.

Although the new plant has been in operation for only three months, the records for this period of time have indicated extremely satisfactory results. On the average, 6 ppm B.O.D. and 6 ppm suspended solids are being discharged into the Creek with the plant efficiency ranging from 96% to 98%.



FLOW DIAGRAM—Irwin Creek bio-activation treatment plant.

Acknowledgment

The contract plans and specifications were prepared by J. N. Pease and Company, Engineers-Architects, Charlotte, N. C. Acknowledgment is given to Mr. Walter M. Franklin, Superintendent of the Charlotte Water Department; Mr. Robert S. Phillips, Assistant Superintendent; Mr. Lee S. Dukes, Head Chemist; and Mr. E. L. Nance, Chief Operator at the Irwin Creek Sewage Treatment Plant, for their cooperation before, during and after the construction of this plant. A list of the contractors and equipment manufacturers is shown on preceding page.

Everts to Direct Construction Grants Program

Curtiss M. Everts of Portland, Oregon, has been chosen to direct initial operation of the construction grants program authorized by the new Federal Water Pollution Control Act. Dr. Leroy E. Burney, Surgeon General of the Public Health Service, announced the appointment.

This act provides for grants of $50 million during the current fiscal year to assist municipalities in the construction of sewage treatment works needed for pollution control and water conservation. The program marks a new step by the Federal Government to further local and State efforts to control pollution of streams and conserve the Nation's diminishing supply of usable water.

Mr. Everts, on leave from duties as chief sanitary engineer of the Oregon State Board of Health will assist the Public Health Service during the next several months in launching the new construction grants program. Mr. Everts is also secretary and chief engineer of the Oregon Sanitary Authority, and secretary of the Oregon Air Pollution Authority.

Alabama Tech Now Offers M.S. in Sanitary Engineering

Alabama Polytechnic Institute of Auburn, Ala., has recently established a graduate course in Sanitary Engineering, leading to the Master of Science degree or Master of Civil Engineering (M.C.E.).

A.P.I. operates on the quarter system which permits enrollment at any of the four quarters. The M.C.E. degree can be won with four quarters of study. Any person with a Bachelor's degree or its equivalent from an accredited college or university, who has an undergraduate grade average of "B" or better, may apply for admission to the Graduate School.

Financial assistance is available in the form of tax-free graduate fellowships, research and teaching assistantships.

For further information write Prof. Theodore Jaffee, Dept. of Civil Engineering, Alabama Tech., Auburn, Ala.

Bettman Archive

Notes on Water Works Law

by JOHN H. MURDOCH, JR.

Mr. Murdoch is Vice-President of American Water Works Co., Inc., and Chief Counsel of American Water Works Service Co., Inc., Philadelphia, Pa. He has prepared exclusively for *Water & Sewage Works* this series of articles discussing water works law as it applies to source of supply, water quality, and water distribution.

Ninth Installment—Concluded

Legal Aspects of Water Fluoridation—Part II*

THE LEGAL ASPECTS of water fluoridation considered here will be limited to the legal and constitutional questions involved in the question of whether the program may be carried forward. Questions concerning legal responsibility for damages which might be suffered by a user of water to which the public water supply agency has added fluorides are covered by earlier installments of these "Notes" under the subject of "LIABILITY FOR FURNISHING WATER DANGEROUS TO HEALTH", where the general principles are set forth. Of course, there will be no discussion here of the wisdom or lack of wisdom of artificial fluoridation of public water supplies although some of the quotations from court opinions touch on that matter. Legal questions rather than policy matters are the subject of consideration.

Chehalis, Wash.

KAUL v. *CITY OF CHEHALIS*, 277 Pacific Reporter, 2d, 352; Decided by the Supreme Court of Washington, December 2, 1954; Rehearing denied January 13, 1955.

Suit to enjoin city of Chehalis from fluoridating city water supply pursuant to ordinance. The Superior Court dismissed the suit and the plaintiff appealed. The Supreme Court held that the prevention and extermination of dental caries was with the police power. * * *

From the Opinion of the Court: "Appellant challenges the validity of Ordinance No. 653-A adopted June 25, 1951, by the city commissioner of the city of Chehalis. The ordinance provides:

" 'That a source of fluoridation approved by the State Department of Health be added to the water supply of the City of Chehalis under the rules and regulations of the Washington State Board of Health, such addition to be administered in a manner approved by the State Director of Public Health.' * * * *

"In his memorandum opinion, the trial judge said: " 'The questions to be determined by this court are purely legal and constitutional questions, and will be dealt with only from that standpoint. It is of no consequence or importance whether I personally approve or disapprove of fluoridation.'

"With this we agree. Our discussion of the case will likewise be limited. * * * *

" 'If the water is fluoridated, it will be necessary for appellant and all other users 'to use it for domestic purposes including drinking, because there is no other practical source of supply.' * * * *

"Dental caries is neither infectious nor contagious. This, however, does not detract from the fact that it is a common disease of mankind. As such, its prevention and extermination come within the police power of the state. In State v. Boren, 1950, 36 Wash. 2d 522, 525, 219 P. 2d 566, 568, 20 A. L. R. 2d 798, this court said:

*Because of the justifiable length of this ninth installment it became necessary to publish Mr. Murdock's contribution in two parts. Part I appeared in our September issue.—The Editor.

" 'The state, under its police power, has the right, and it is its duty, to protect its people in their health and general welfare. The very existence of government, as well as the security of the social order, depends upon this right. This is especially true as to the health of the people, which affects every man, woman and child within the state.' * * * *

"We find nothing in the ordinance which is in conflict 'with general laws' or which detracts from the constitutional and statutory grants to the city to make and enforce local police, sanitary, and other regulations. Nor do we agree that the fluoridation is ultra vires simply because the police power is exercised through a municipal agency operated by the city in its proprietary capacity.

"Since the city acted in the exercise of its police power for the protection of public health to 'prevent the introduction and spread of (this) disease' among its citizens, the subject matter of this exercise of power, and its expediency, are beyond judicial control, except as they may violate some constitutional right guaranteed to appellant. * * * *

"We fail to see, however, where any right of appellant, guaranteed by the constitution, has been invaded. The instant situation is vastly different from one where appellant is required to take affirmative action and is subject to punishment for failure to act. The ordinance under consideration does not compel him to do anything; it subjects him to no penalty. Liberty implies absence of arbitrary restraint. It does not necessarily imply immunity from reasonable regulations imposed in the interest of the community.

"In some sections of the country, fluoride appears as a natural element in water. When it appears naturally in proportions not deleterious to health, would it be contended that the city could be forced to remove it? * * *

"It would extend this opinion unduly to analyze in detail each of the cases cited by appellant. It is sufficient to point out that they fall into two categories, neither one of which changes the opinion already expressed.

"The first contains those cases where the courts have held it a valid exercise of the police power, for the protection of public health, to prevent the introduction or spread of *contagious* or *communicable* diseases. Jacobson v. Massachusetts, 1904, 197 U. S. 11, 25 S. Ct. 358, 49 L. Ed. 643, 3 Ann. Cas. 765 (compulsory adult vaccination with penalty for refusal) and 155 Ind. 121, 56 N. E. 89, 50 L. R. A. 64, 80 Am. St. Blue v. Beach, Rep. 195 (compulsory vaccination of children as a condition to entering or remaining in public school) are illustrative of appellant's first category of authorities. In the main, the cases are based upon the theory of 'the pressure of great danger.' From the cases of this type, appellant argues, that since the instant case involves a *noncontagious* disease, which does not present a grave and immediate danger to the public, and extension of the police power to the situation results in an invasion of his constitutional rights.

"This conclusion depends upon a refinement we are unwilling to make. Protection of public health includes protection from the introduction or spread of both contagious and non-contagious diseases. There is a direct and significant relationship between dental health and general bodily health of individuals. We find nothing in this jurisdiction which limits the police power, exercised in the realm of public health, solely to the control of contagious diseases, as distinguished from noncontagious diseases. Further, under the police power, a health regulation may be an effective police measure, without the existence of some immediate public necessity.

"State ex rel. Bolling v. Superior Court, 1943, 16 Wash. 2d 373, 133 P. 2d 803 (compulsory flag salute held unconstitutional); West Virginia State Board of Education v. Barnette, 319 U. S. 624, 63 S. Ct. 1178, 87 L.Ed. 1628 (compulsory flag salute unconstitutional); and Pierce v. Society of Sisters of Holy Name of Jesus and Mary, (Pierce v. Hill Military Academy), 1925, 268 U. S. 510, 45 S. Ct. 571, 69 L. Ed. 1070 (compulsory attendance of all children at public schools held unconstitutional) illustrate the second class of cases upon which appellant relies. They are distinguishable from the instant case; They involve statutes requiring affirmative action by the individual, with a penalty for refusal to act. Such is not the instant case. * * * *

"Finally, neither the alliterative term 'compulsory mass medication' nor reference to the fluoridated water as a 'concoction' describes the situation before us; nor does the possible opprobrium, which may flow from their use, overcome the police power. * * * *"

(NOTE: Five Justices for Judgment for City. Four Justices Dissent).

Cleveland, Ohio

KRAUS v. CLEVELAND, 116 N. E. 2d 779; Kraus, a Taxpayer, Appellant, v. City of Cleveland, et al., Appellees. 163 O. S. 559; Certiorari denied by U. S. Supreme Court, May 21, 1956. (No. 34190—Decided June 29, 1955).

APPEAL FROM THE COURT OF APPEALS FOR CUYAHOGA COUNTY

"After public hearings thereon, certain ordinances and resolutions were passed and adopted providing for the fluoridation of such water, for the purpose of preventing dental caries.

"Whereupon the plaintiff, appellant herein, brought a taxpayer's action, seeking a permanent injunction restraining the city and others, appellees herein, from expending money for the fluoridation of the water and from entering into any contracts therefore, to declare the resolutions and ordinances unconstitutional and void and to declare void any contract already entered into. * * * *

Quoted: "MATTHIAS, J. Essentially, the plaintiff attacks the legislation on two grounds, first, that it infringes upon certain of his fundamental liberties, and, second, that it conflicts with certain statutes of the state and is beyond any power granted to municipalities by the laws and the constitution of Ohio. * * *

"The basic question presented by this case is whether a municipality has the authority under its police power, in relation to public health, to add inorganic fluoride chemicals to its water supply, where such addition will not and is not intended to have any effect on the potability, palatability or purity of such drinking water but has for its sole purpose the prevention of dental caries.

"The plaintiff contends that the prevention or treatment of diseases of the teeth is a matter of private health and not of public health, and that the addition of fluoride chemicals to the water supply constitutes an invasion of his constitutional liberties to treat his health as he deems best, his right as a parent to safeguard the health of his children as he deems best, his right to be free from medical experimentations and his right of freedom of religion.

"The personal liberties granted by the Constitution, although broad and on the whole inviolate, are nevertheless subject to certain qualifications and restraints and are generally held to be subject to a valid exercise of the police power. * * * *

"The objecting water user, while admitting that personal liberties are not wholly free from restraint, contends that, for a valid exercise of the police power on the basis of public health, the subject matter of the regulation

must relate to contagious or infectious diseases, and that there must exist an overriding necessity.

"In regard to this, it is sufficient to say there is no foundation in law for such a premise. An examination shows that laws relating to child labor, minimum wages for women and minors and maximum hours for women and minors have all been upheld on the basis of the police power in relation to public health. Regulations relating to control of venereal disease, blood tests for marriage licenses, sterilization, pasteurization of milk, chlorination of water and vaccination have all been held valid as based on police power exercised in regard to public health.

"Clearly neither an overriding public necessity or emergency nor infectious or contagious diseases are the criteria which authorize the exercise of the police power in relation to public health.

"That dental caries is a disease is not questioned, and its prevalence is well recognized, as is the fact that the health of the teeth bears a direct relationship to general physical health. * * * *

"It is argued that the same result might be accomplished by private dental care, and, since there is an alternative to public regulation, the police power may not be invoked. Although it is admitted that private care would be as effective, the record shows that there are not sufficient private dental facilities to perform the task. Under our modern existence the law must change and expand with mechanical and scientific progress. What did not concern public health yesterday, because of an inability of science to cope with the problem at hand, may very well today become a matter of public health due to scientific achievement and progress. The use of fluoridation to prevent dental caries is an excellent example of this proposition. Science has discovered a method whereby dental caries may be diminished. The prevalence and danger of such caries are well known and the only practicable application of such scientific knowledge is by treating drinking water with fluoride. Thus the problem of dental caries has of necessity become one of public health. * * * *

"It is clear from the record that the fluoridation of water for the prevention of dental caries has progressed far beyond the experimental period and has now become an established method. The facts that there are still differences of opinion as to its value and effect by a number of persons and that there are certain questions unanswered in relation to fluoridation do not make it an experiment. There are dissenters to many established and proved scientific practices which are accepted today. Dissent to scientific method does not constitute such method an experiment, and plaintiff's contention that fluoridation constitutes experimentation is without foundation.

"Plaintiff's argument that fluoridation constitutes mass medication, the unlawful practice of medicine and adulteration may be answered as a whole. Clearly, the addition of fluorides to the water supply does not violate such principles any more than the chlorination of water, which has been held valid many times. * * * * *

"To summarize:

"I. Although dental caries does not constitute a contagious or infectious disease, it is a disease so common and so widespread that it is a proper subject, in relation to public health, for a municipal corporation to act upon in the exercise of the police power.

"II. The introduction of inorganic fluoride chemicals in its municipal drinking water does not constitute an infringement of the constitutional liberties of the citizens of such municipality or an excerise of power in contravention of the general laws in relation to adulteration or practice of medicine.

"The judgment of the Court of Appeals is affirmed. Judgment affirmed.

"Weygandt, C. J., Hart, Zimmerman, Stewart, Bell and Taft, JJ., concur."

New Castle (Pa.) Water Co.

IN THE COURT OF COMMON PLEAS OF LAWRENCE COUNTY, PA.

JACK M. GENKINGER, VICTOR W. HOVE, AND CLINTON D. KEAGY
vs.
CITY OF NEW CASTLE WATER COMPANY, A CORPORATION, AND DEPARTMENT OF HEALTH OF THE COMMONWEALTH OF PENNSYLVANIA

NO. 1
JUNE TERM
1954
IN EQUITY

ADJUDICATION

Braham, P. J. March 4th, A. D. 1955

This is an action in equity brought by three citizens against the water company to enjoin it from adding a compound of fluorine to the public water supply. The Commonwealth of Pennsylvania was allowed to intervene as party defendant. The Pennsylvania State Dental Society also sought to intervene as party defendant. This was not allowed but the Society was heard as amicus curiae. The plaintiffs were allowed to amend to show that they were acting on behalf of themselves and all who might seek to join. * * * *

FINDINGS OF FACT

* * * *

2. Fluorine itself is a poison and sodium silico fluoride is a highly toxic substance. It is not added to drinking water as a purifying agent but to prevent dental caries by strengthening the teeth of children under the age of twelve and particularly the enamel of the teeth. There is a method of applying fluorine to the teeth topically.
* * * *

4. Experience with fluorine in natural water has demonstrated that in excessive quantities, i.e., large in excess of 1.2 per million, it would cause mottling of the teeth.

5. There is no competent evidence of record to the effect that the consumption of water containing 1.0 to 1.2 parts per million of fluorine will endanger public health or have any deleterious effect upon the human body.

6. The evidence of competent witnesses who testified for defendant and the intervening defendants, as well as the public records as to the effects upon inhabitants of communities where water containing 1.0 or more parts per million has been consumed for extended periods of time, establish that the consumption of water containing 1.0 to 1.2 parts per million of fluorine will not in any way endanger public health nor have any deleterious effect upon the human body.

7. Treatment of dental caries through community water supplies containing 1.0 to 1.2 parts per million of fluorine has passed beyond the experimental stage and is now merely the application of known procedures, proven to be safe, to secure needed public health benefits.

8. In 1953 the members of the medical and dental professions in New Castle, mindful of the aid in combating dental caries to be derived from the use of fluorine in the public drinking water, began agitating for its use here.

To this end the Lawrence County Medical Society and the Lawrence County Dental Society adopted resolutions favoring the use of fluorine here. The movement went further and the Council of South New Castle Borough, and the supervisors of Neshannock, Union, and Hickory Townships took action favoring the projects.

9. Application was made to the defendant New Castle Water Company to add fluorine to the public water supply, whereupon the Water Company, acting on what it believed to be general public demand, on November 16, 1953, filed a written application with the Department of Health of the Commonwealth of Pennsylvania for permission to do so. * * * *

10. Prior to the filing of the application by the defendant Water Company, to-wit: on July 9, 1951, the Department of Health of the Commonwealth had promulgated a written statement of policy favoring the treatment of the public water supply with fluorine in terms of one part per million, * * * . The policy of the department was particularly adapted to public water works. It required a permit from the Department, the application for which must be accompanied by the written endorsement of the local health, medical and dental authorities.

11. The application filed by the City of New Castle Water Company complied with the requirements of the Department. * * * *

13. The Department of Health of the Commonwealth Pennsylvania did on November 7, 1953 authorize the New Castle Water Company to add sufficient silicofluoride to the public water supply to bring the fluoride content of the treated water up to 1.0—1.2 parts per million. This was intended to be issued and was issued by the Secretary under his broad power to protect the health of the people of the state.

14. The defendant, City of New Castle Water Company, has charter power to supply water to the public in the city of New Castle, the borough of South New Castle and the townships of Neshannock, Union and Hickory.

15. The defendant is treating the water supplied by it within its charter territory by the addition of sufficient sodium silicofluoride to bring the fluorine content of the finished water to 1.0 to 1.2 parts per million. * * * *

19. Defendant is treating its water supply with sodium silicofluoride in response to a public demand expressed to it in resolutions recommending such action adopted by the governing bodies of each municipality in which the defendant serves.

20. The defendant's treatment of its water supply so as to produce finished water containing 1.0 to 1.2 parts per million of fluorine will in no way endanger plaintiffs and plaintiffs have failed to establish any injury to themselves, either actual, threatened or even reasonably anticipated.

21. Consumption of water containing 1.0 to 1.2 parts per million of fluorine greatly reduces the incidence of dental caries through its effect on children when their dentures are in the formative stages.

22. The addition of fluorine to public water supplies so as to bring the concentration of the finished water to 1.0 to 1.2 parts per million is an effective means of combating the public health problem created by the prevalence of dental caries.

DISCUSSION

This is a contest between three private citizens who believe that the addition of compounds of fluorine to the public drinking water is dangerous to the public health, on the one side, and the Water Company and the Department of Health of the Commonwealth of Pennsylvania on the other, who defend the practice. The Pennsylvania Dental Society has appeared as amicus curiae and lends its support to the defendants. Plaintiffs have invoked the power of the court of equity to enjoin the water company from adding fluorine to the water.

* * *A public utility company is being employed by the Department of Health to furnish medical treatment to the young of the Commonwealth in the hope of improving the public health. Plaintiffs have furnished some evidence that the proposed treatment is of doubtful efficacy and of possible menace to the public health.

The case comes within the spirit of the Act of June 19, 1871, P. L. 1360, 12 P. S. 1315 which allows courts to hear the complaints of citizens regarding the conduct of corporations. The Water Company claims the right, as agent of the Commonwealth and local municipalities, to add a substance to the water which plaintiffs contend is deleterious to their health and the health of the public. If this is true the defendant Water Company is committing a nuisance cognizable in equity: 4 Pomeroy's Equity (5th) Ed. 1953; Sanderson vs. The Penna. Coal Co. 86 Pa. 401. Defendants argue that plaintiff's right is not a property right citing Andel vs. Duquesne Street Railway Co. 219 Pa. 635, 639. Plaintiffs have a contract status with the water company. They are customers and, perforce must be customers and as such have a right not to have harmful substances put in their water.

Defendants argue that only the Attorney General has the right by quo warranto to bring the suit citing Croyle vs. Johnstown Water Co. 259 Pa. 484 and Citizens Electric Co. vs. Susquehanna Boom Co. et al. 270 Pa. 517. But plaintiffs are not trying out some abstract right. They are seeking to determine whether this new thing may lawfully be done, to the detriment of their health, as they contend. This is historically and logically for the courts of equity.

Having determined that the complaint of plaintiffs may be lawfully entertained in a court of equity, the court must next decide whether plaintiffs have been harmed or are likely to be harmed by the treatment of the water. Here the disadvantageous position of the plaintiffs as to matters of proof ust be noted. The problem is one of scientific principles and expert proof is required, a type of proof not readily available here. Plaintiffs produced one witness, Charles Elliott Perkins, the weight of whose evidence will be commented on later. The defendants had a number of expert scientific witnesses whose evidence was quite impressive. * * * *

The overwhelming weight of the evidence is to the

effect that the treatment of drinking water in the proportion of one part or 1.2 parts to one million will have a very beneficial effect on the teeth of the young and may be done without danger to anyone. This is what the court finds from the evidence. * * * *

Who is to determine whether fluoridation of water is to go forward as the great majority of scientific men believe wise or is to be halted as the minority believe? Here enters what is believed to be the vital consideration in the case. The legislature has committed to the Department of Health and its Secretary the responsibility for making these decisions in the first instance. The language of the statute is clear and emphatic. The Act of 1905 as amended (71 P. S. 1403 & 71 P. S. 76) empowers the Secretary

> "To protect the health of the people of the state, and to determine and employ the most efficient and practical methods for the prevention and suppression of disease."

Section 15 of the Act of 1905 as amended (71 P. S. 1408) authorized the Department to make rules and regulations. The Act of May 24, 1927 P. L. 61, 71 P. S. 1411 authorizes municipalities to cooperate with one another and with the Department of Health to enforce the health regulations of the Department.

In the oleomargerine cases, Powell vs. Com. of Pennsylvania 127, U.S. 678, 32 Law. Ed. 253 affirming 114 Pa. 265, the respective areas of the legislature's authority and the court's authority are stated as follows:

> "The determination by the legislative body that a particular regulation is necessary for the protection and preservation of health is conclusive on the courts except only to the limitation that it must be a reasonable determination, not an abuse of discretion and must not infringe upon the rights secured by the Constitution."

The power of the legislature to delegate this type of power to a board or commission is illustrated by the Milk Control Law where control of a whole industry, including the right to fix prices, has been turned over to a commissioner: Rohrer vs. Milk Control Board 322 Pa. 257.

Plaintiffs argue strongly that the principle of these cases does not apply because plaintiffs are being deprived of a constitutional right to treat their own infirmities. This claimed right like so many others in the modern world must give way to the exercise of the police power of the state for the public good. There are not enough dentists, say Dr. Teague and his staff, to fill all the cavities. Fluoridation of the water is the only practical method available to combat dental caries. The police power is the paramount power of government: Com. vs. Widovich et al., 295 Pa. 311.

Is the treatment of the public water supply with fluorine an irresponsible experiment or a proper exercise of the police power of the Commonwealth? Russell A. Teague, Secretary of Health, testified that by licensing the defendant Water Company to add fluorine to the water he was taking what he believed to be the most efficient and practical means to combat the disease known as dental caries * * * *

Rather, all the evidence shows a conscientious attempt to use the power of the Department of Health to improve the public health. The City of New Castle and the other municipalities involved have added their support to the movement. Whatever power they have to take action to improve the public health has been taken. The defendant Water Company, although disclaiming any private interest in the matter, has acted as agent for the governmental bodies in carrying forward the project. * * * *

Plaintiffs' contention that the action of the defendants in the case at bar is unconstitutional, because it applies to one class, and must be rejected. The disease of dental caries must be attacked where the attack will be successful and so long as others are not harmed it is of no moment. * * * *

The views of this court that the action here in review is a constitutional exercise of the police power is supported by all the adjudicated cases in the courts of last resort in the country. * * * *

The police power is as wide as the widening needs of the people. The health regulations here involved represents an intelligent and conscientious attempt to benefit the health of all people by the application of the latest techniques developed and approved by scientists. * * * *

IN THE COURT OF COMMON PLEAS OF LAWRENCE COUNTY PA.

JACK M. GENKINGER, et al
vs.
CITY OF NEW CASTLE WATER COMPANY

NO. 1 JUNE TERM 1954
Before the Court in banc on Exceptions to Adjudication

OPINION

Plaintiffs have filed some twenty-six exceptions to the adjudication; but their main contention, raised by their 20th exception, is that it was ultra vires for the Water Company to treat the water supply with fluorine. It is axiomatic that a corporation being a creature of the state has no powers except those conferred upon it by the legislature: Bangor Electric Co. Petition 295 Pa. 228; Citizens Electric Illuminating Co. vs. Lockawanna and Wyoming Valley Railroad Co. 255 Pa. 176. Generally it is only the state which has the right to proceed against a corporation for violation of the powers granted it by charter or for usurpation of pwers not granted: Corporations 13 Am. Jr. page 1067. Par. 1147. The private citizen with only the right of every other citizen has no right to take legal action against a corporation on the ground that its acts are ultra vires; the Attorney General is ordinarily the one to act. In this state, however, the Act of June 19, 1871, P.L. 1360, 12 P.S. 1315, allows suit by private persons. The pertinent language is as follows:

> "In all proceedings in courts of law or equity of this Commonwealth, in which it is alleged that the private rights of the individuals or the rights of franchises of other corporations are injured or invaded by any corporation claiming to have a right or franchise to do the act from which such injury results, it shall be the duty of the court in which such proceedings are had, to examine, inquire and ascertain whether such corporation does in fact possess the right of franchise to do the act from which such alleged injury to private rights, or to the rights and franchises of other corporations results, and if such rights or franchises have not been conferred upon such corporations, such courts, if exercising equitable power, shall, by injunction, at suit of the private parties or other corporations, restrain such injurious acts; and if the proceedings be at law for damages, it shall be lawful therein to recover damages for such injury as in other cases."

Plaintiffs have relied upon the contention that the acts of the Water Company were ultra vires and the defendants have constantly countered with the contention that only the Commonwealth has the right to raise the question. The problems now appears in a different light. The trial judge allowed plaintiffs to challenge the legality of the procedure because of their contention that their lives and health were in danger because of the treated water. Now the Court has found that no such danger exists. Does the Court have the right or is it under a duty to enjoin the treating of the water with fluorine, not because

the treated water is dangerous but because the conduct of the Water Company is alleged to be ultra vires.

The rule that the Act of 1871 authorizes the court to make an inquiry to determine whether the plaintiffs have suffered actual damage but, lacking such damage, does not authorize the court to proceed and decide those matters of general concern with which the attorney general is presumed to be particularly aware, applies with great force in this case. The action of the Department of Health and of the Water Company has been taken in the exercise of the police power. A large area of governmental policy is involved. If the power of the corporation to carry out the directions of the health department is to be challenged as ultra vires it should be at the suit of the attorney general. * * * *"

Some Answers to Questions Submitted to the Author

Question 1—In what respect, if any, is there a different status for privately owned and municipally owner water utilities?

Answer 1—As respects the matter of fluoridation there is little, if any, difference in status. Where a water utility is municipally owned the *municipality* acts in its proprietary capacity when it operates the water works system. The water system has no legislative powers and so could not enact such a police power law as would be required to force fluoridation on unwilling customers. The local municipal legislative body, acting on a governmental capacity, or a public health agency, if properly empowered by the state, could adopt the required ordinance, resolution or order and require the water system to act under it. Here the water system owned by the municipality would be *acting as the agent* in carrying out a legislative mandate enacted under the police power. Essentially the same is true with respect to a privately owned water utility. It likewise *acts as the agent* of the issuer of the order or, perhaps, as an entity required to obey a valid police regulation. (See case of City of New Castle Water Company, reported herein)

This brings up the matter of ultra vires. Note the opinions of the courts in several of the cases cited to the effect that fluoridation is not contamination, is a modern development of recognized value to public health and that fluoridation ordinances are valid police power enactments. Could either a publicly or privately owned water system be held to be acting beyond its corporate powers, if in carrying out its original function it incidentally and without interference with its original function, performed and added function required of it by constituted authority? The answer is—"NO, the system would not be guilty of an ultra vires act."

Question 2—Is fluoridation a governmental function—a police power in the interest of the majority, or is it a proprietary function in the case of a private water company?

Answer 2—The enactment of a fluoridation statute, or resolution or order of a regulatory body, would be a *governmental* function. The *act* of fluoridating the water supply for the agency—public or private—would be a *proprietary* function.

Question 3—Is fluoridation treatment constitutional?

Answer 3—Yes, unless the enactment on which it is based is improperly drawn.

Question 4—Is it medication or is it water fortification with trace elements?

Answer 4—This is not a legal question. However, from a legal standpoint it is immaterial what fluoridation is if its use does accomplish a beneficial public health result. (See Dowell v. City of Tulsa, supra.)

Francis Friel New ASCE Vice President

Francis S. Friel, President of Albright & Friel Inc., Consulting Engineers of Philadelphia, has been elected Vice President of the American Society of Civil Engineers. He was inducted into office at the annual meeting of the Society.

Mr. Friel is the immediate past President of the American Institute of Consulting Engineers. He is the chairman of the United States Committee on Large Dams of the International Commission on Large Dams, and he has represented the United States at meetings of this group in Stockholm, Sweden; Bombay, India; Paris, France and Lisbon, Portugal. He is also the the immediate past President of the Pennsylvania Section of the American Water Works Association, and in 1947, he was President of the Federation of Sewage and Industrial Wastes Association.

In addition to his professional activities, he is also a member of the State Registration Board for Professional Engineers in the Commonwealth of Pennsylvania.

Manual on Low Dams

A 'Manual for the Design of Low Dams" for small water-storage projects is available from the Supt. of Documents, Washington, D. C.

This movement for small dam design represents a probing of interests and efforts of Federal Agencies concerned with small dams. Types of low dams covered are earth and rock-fill dams, concrete and masonry, gravity dams, single-arch dams, buttress dams, timber dams. This volume of 431 pages (illustrated) covers construction, operation and maintenance, as well as information on associated subjects.

Copies may be purchased at $2.75 in cloth binding by remitting to the Supt. of Documents, Washington 25, D. C.

Lawrence Waterbury Opens Engineering Office

Lawrence E. Waterbury has retired as general partner from the engineering firm of Parsons, Brinkerhoff, Hall & MacDonald and has established his own consulting engineering office at 26 Broadway, N. Y. City. Mr. Waterbury will, however, continue to serve his former firm as consultant while conducting his own personal practice.

"SO, the Mayor sent you down to work on my Sewer Maintenance Crew, did he!"

74th Annual Convention

New England Water Works Assn.

RAIN, RAIN, RAIN and more rain failed to dampen the spirits of 643 persons who registered at the NEWWA meeting held September 16-20 at the Mt. Washington Hotel, Bretton Woods, N. H. On only one of the four days did the sun shine and except for a few hardy golfers, most of the registrants spent their time indoors, listening to technical sessions, sleeping, playing cards, eating (and

Ret. Pres.
A. F. McAlary

President
Ed. L. Tracy

1st V. Pres.
Geo. G. Bogren

2nd V. Pres.
C. L. Ahlgren

Officers

what meals) and visiting at the many manufacturers' hospitality rooms.

On the one clear day when the top of Mt. Washington could be seen, there was a considerable amount of business for the famous cog railway which ran extra trains to accommodate the water works people. Evenings were given over to a square dance one night, entertainment and dancing a second night, and a cocktail party, banquet and dance the third night. The cocktail party was given by the Water & Sewage Works Mfrs. Assn.

New Officers

As is customary at the annual NEWWA banquet, the new officers were announced and presented as follows:

President: Edward L. Tracy, Chief, Bur. of Envir. San., State Dept. of Health, Burlington, Vt.

1st Vice President: George G. Bogren, Partner, Weston & Sampson, Consulting Engineers, Boston, Mass.

2nd Vice President: Clarence L. Ahlgren, Asst. Supt., Water Works, Manchester, N. H.

Directors: W. A. Gentner, Water Bureau, Metropolitan District of Hartford, Conn; Kenneth W. Robie, Supt., Water Dept. Brookline, Mass; Peter C. Karalekas, Chief Engr., Muni. Water Works, Springfield, Mass.

Treasurer: William P. Melley, Water Commissioner, Milton, Mass.

Secretary: Joseph C. Knox, Secy., New England Interstate Water Pollution Control Comm., Boston, Mass.

Editor: George C. Houser, Brookline, Mass.

Honors and Awards

The Dexter Bracket Memorial Medal was presented to Thos. R. Camp and Darrell A. Root, Cons. Engrs. of the firm Camp, Dresser and McKee in Boston, for their joint paper "Determination of Charges for Public Fire Protection" published in the Jour NEWWA in March, 1955. This is the second Dexter Bracket Medal which Mr. Camp has won and this year; he was also awarded the Rudolph Hering Medal of ASCE for his paper on "Flocculation and Flocculation Basins".

The Annual Commemorative Award was made, in memory of George C. Whipple, to Richard S. Woodhull, San. Engr., Conn. State Board of Health, for his paper on "Tastes and Odors in Connecticut Water Supplies".

Business Meeting

Membership has now climbed to 1122 and the circulation of the Journal is 1387, according to the report of the Secretary. Continued increases in the cost of publishing the Journal and increases in other operating expenses again made it necessary to prepare a deficit budget. For this reason, the Finance Committee proposed that the dues be raised, an action which will be considered by the Executive Committee.

St. Lawrence Project

Wm. P. Hall, Vice Pres., Charles T. Main, Inc., Boston, Mass., presented an illustrated talk on the ST. LAWRENCE POWER PROJECT. Mr. Hall reviewed the history of this great project and pointed out that there are two parts to the undertaking, power development and navigation. The seaway part of the project is a separate undertaking being financed by the federal governments of the United States and Canada, to be repaid by tolls. The power project, however, is a joint venture of the Power Authority of the State of New York and the Hydro-electric Power Commission of Ontario. The power project is financed by $335,000,000 of bonds. Since interest on the bond issue runs from $1 to 1.5 million a month, construction time is important.

By means of slides, Mr. Hall showed various stages of construction of several dams and how these units would fit into the ultimate plan. Fortunately for power production, the flow in the St. Lawrence River is fairly constant, varying, over a period of years, only ±10 per cent from an average flow of 252,000 cfs.

Three R's

Harry A. Faber, Research Coordinator, Div. of San Engng. Service, Public Health Service, Washington, D. C., spoke on the THREE R'S OF SANITARY ENGINEERING—RESOURCES, RESEARCH, AND RESULTS. Mr. Faber called attention to the dwindling water resources in this country, remarking that by 1975 we may be using 90 per cent of the water that can be developed economically.

Civilization is bound to pollute rivers and we may soon overtax this resource. One of the largest problems now looming on the horizon is that of radioactive wastes. From the atomic power plants to be built by 1964 we may expect 90 mil gal of radioactive wastes. Dilution alone will not reduce

the radioactive value to the maximum permissible limits.

Mr. Faber did not predict that we could not or would not solve this problem, but he did say a shortage of brain power in sanitary engineering made the problem that much more difficult to solve. Inasmuch as sanitary engineering embraces such a wide range of sciences, there is a big problem of training scientists. Low salaries in the sanitary engineering field fail to attract even a fair share of scientists; furthermore, when it is realized that of every 1000 children entering primary schools only 30 ever become college graduates in science and engineering. Thus this resource is extremely limited since only a very small percentage of these 30 enter sanitary engineering. We need not only more students entering science and engineering but higher salaries to attract those scientists and engineers to sanitary engineering.

In the matter of research, the limiting factor is brain power or the number of trained brains devoted to sanitary engineering research of all kinds including fundamentals, applied research, engineering development and process design. One of the sources of help in research is the U. S. PHS with its Sanitary Engineering Center at Cincinnati, its field programs, its training programs, and its research grants.

Mr. Faber said there are five types of research being conducted at the Robt. A. Taft Sanitary Engineering Center. These are 1) Chemical, bacteriological, and virus pollution of water, 2) new types of chemical wastes reaching streams, 3) development of more effective means of treatment, 4) radioactive waste disposal and 5) evaluation of the pollution load on the capacity of water treatment plants.

The Public Health Service began its research grant program in sanitary engineering in 1947 with a total of $66,000; in 1955 the grants totalled $570,000, but this rate of increase has lagged far behind research grants in other fields through the Nat. Insts. of Health. Mr. Faber gave some statistical data, not only to show this lag but to indicate the number, location and type of projects under way in sanitary engineering.

In New England, 26 projects have received support, seven are now under study and four of these deal with water supply or water pollution. In the past 10 years there have been $10 million spent on 120 projects at 60 institutions in 30 states.

Results of research are not only important but are highly valuable. Research is big business in the United States. For each $100 spent on research there is a return of $2500 to $5000 each year for 25 years. Furthermore, we recognize that the practical methods of water treatment today are based on fundamental studies of 40 years ago.

Mr. Faber concluded by mentioning several results of recent and current studies, particularly the studies at the Ill. State Water Survey on the effect of water treatment on distribution systems; at the Mich. State Univ. on solubility and toxicity of metals; at the Univ. of Florida on coagulation; and at the Univ. of California on the harvesting of algae from waste treatment.

Vertical Pumps

D. T. Johnstone, Mgr., Turbine & Propeller Pump Sales, Fairbanks, Morse & Co., Pomona, Calif. presented an illustrated paper on APPLICATION AND USAGE OF THE MODERN VERTICAL PUMP. He set the theme of his talk when he said "For the past 20 years, there has been a trend toward the usage of vertical turbine, propeller and mixed-flow propeller pumps for applications previously considered as horizontal centrifugal application."

Treas.
W. P. Melley

Secy.
Jos. C. Knox

Awardee
Thos. R. Camp

Program Chm.
Ken F. Knowlton

Originally the vertical turbine pump was developed for deep well use, but now it is being used for many other applications. Principal reasons for this rise in popularity are these five characteristics:

1) A steeper head-capacity curve with a corresponding non-overloading horse power curve.

2) Simplification of alignment and foundation problems in installation.

3) Lateral space saving, resulting in reduced overall station costs.

4) Flexibility by multi-staging for head variation.

5) Complete elimination of primary problems.

The remainder of Mr. Johnstone's talk was devoted to the current construction details of the modern turbine pump with particular reference to the three principal components. These components are (1) the discharge head with driver mounted thereon, (2) the column and drive shaft assembly connecting the discharge head to the pumping element, and (3) the pumping element consisting of impellers and diffuser bowls submerged in the fluid. Slide illustrations were used to point out particular details.

Submersible Motors and Pumps

John E. Hawkes, Chief Engr., Fairbanks, Morse & Co., Pomona Works, Pomona, Calif. read a paper on APPLICATION AND OPERATION OF SUBMERSIBLE MOTOR AND PUMP. He pointed out that the submersible motor has removed the depth obstacle to pumping equipment and makes new sources of water available, because the submersible motor converts electrical power to mechanical power under water.

The primary problem is to protect the electrical components while simultaneously providing suitable motor bearings. By means of illustrations, Mr. Hawkes described the details of three successful approaches to the submersible motor in the United States. These three motor constructions are the oil-filled motor, the wet-stator motor and the dry-stator motor.

All these incorporate sleeve type radial bearings, tilting pad type thrust bearings and at present are limited to squirrel cage induction type motors. Basically, the pumping element must first meet the head and capacity requirements of a given job. Semi-open impeller construction is favored by some manufacturers because, in general, it will produce more water for a given size pump and total pumping head, but it also has the ability to handle solids without "sand-locking" during successive start-stop operations and to withstand wear.

After presenting the details of various designs of submersible pumps and motors, Mr. Hawkes discussed plication advantages of this type of pump. In particular he mentioned advantages for deep settings, crooked

wells, usage of full motor output, ease of installation, surface appearance and lack of noise, and maintenance reduction. He closed his talk with comments on starting and control methods, lightning protection, low water level cut offs, time delay relays to prevent cycling damage, and pressure and other control switches.

Supervisory Control

Russel H. Babcock and Robt. E. Burrell, Engineers, The Foxboro Co., Foxboro, Mass. presented an illustrated talk on SUPERVISORY CONTROL SYSTEMS. Mr. Burrell talked about the importance of telemetering, the types of channels used; the advantages of D.C. transmission over A.C.; multiplexing or the sending of more than one signal over a single channel.

There are two types of signals; time-sequential and frequency-simultaneous or audio-tone. The former requires a switching unit and can not easily transmit in two directions; the latter can send several signals at the same time in two directions. The frequency-simultaneous system uses one voice channel of 300 to 3000 cycles per second. Individual signals are spread 120 cycles apart to avoid interference.

Mr. Babcock spoke specifically on the application of supervisory remote control and illustrated the various applications of pump and level control by means of slide illustrations of actual installations made by the Foxboro Co.

Cast Iron Pipe Specifications

Thos. F. Wolfe, Man. Director, The Cast Iron Pipe Research Assn., Chicago, Ill. gave a talk on CURRENT SPECIFICATIONS FOR CAST IRON PIPE AND HOW TO ORDER TO SPECIFICATION. Mr. Wolfe reviewed the history of specifications for cast iron pipe, the first of which was developed by the New England Water Works Assn. in 1902. The ASTM standards followed in 1906 and the first AWWA standards appeared in 1908. These all covered only pit cast pipe. In 1926, Federal specifications included centrifugally cast pipe. The original design formulas did not include trench loading, etc. but indeterminate factors of safety were sufficient.

In 1926 the American Standards Association created Committee A21 with Thomas H. Wiggen as Chairman and the present standards have been developed from thirty years work of that committee, which was composed of both users and producers with the users in the majority.

Program

H. A. Faber R. H. Babcock

Since the present ASA specifications are keyed to how the pipe is laid, Mr. Wolfe showed slides illustrating the four laying conditions:

A. Flat-bottom trench, without blocks, untamped backfill

B. Flat-bottom trench, without blocks, tamped backfill

C. Pipe laid on blocks, untamped backfill

D. Pipe laid on blocks, tamped backfill

Specifications are not only keyed to these four basic conditions but also depth of cover whether it be 3½ ft., 5 ft. or 8 ft. Size, thickness, outside diameter, weight per foot, are standardized according to working pressure under each of these four laying conditions.

The new ASA standards cover pit cast pipe, centrifugally cast in metal molds, sand lined molds, short body fittings, mechanical joint pipe and cement lined pipe. Mr. Wolfe said that to choose pipe, follow these steps:

1- Pick the working pressure.

2- Determine the laying condition.

3- Determine the thickness required.

4- Determine the class no. and order the pipe.

The new standards have the same number of classes as the old standards and the same outside diameter specifications. If engineers wish they may order the pipe to meet the worst possible conditions of laying or they can order the same thickness of pipe as previously used. Some buyers still buy with the safety factor of a slightly thicker pipe than the specifications indicate necessary.

In answer to a question, Mr. Wolfe said that the new Federal Specifications are the same as the ASA Standards. Paul Howard, Cons. Engr. of Boston stated that he had ceased to specify inspection by an outside agency (other than the manufacturer's own inspection) because it increased the price of the pipe and did not insure any better pipe. Actually, today, the suppliers comply with ASA Specifications regarding inspection and the buyer can have confidence in such inspection.

St. Johns, N. F. Water Supply

Robt. D. Mitchell, Partner, Malcolm Pirnie Engineers, New York City, gave an interesting illustrated account of the WATER SUPPLY OF ST. JOHNS, NEWFOUNDLAND. He explained the topography of the island, the old supply, and the development of a new supply. Since most of the city is composed of old frame houses, the need for fire protection is great. High per capita consumption on flat rates, leaking mains, and a growing community underlined the need for improving and expanding the system and source of supply.

The plan developed and now under way included leak surveys and main repair, complete metering, chlorination of the distributing reservoir, and construction of a new dam on a small lake to increase the source of supply by some 25 per cent.

Distribution System Survey

Frances N. O'Hara, Supt. of Pub. Wks, Arlington, Mass. told of a PRESSURE AND VOLUME SURVEY, TOWN OF ARLINGTON, MASS. It was following a big fire that the decision was made to determine the fire protection capacity of the town's water system. The survey undertook to determine areas where water supply was insufficient, how much water was available, main sizes, hydrants, etc. Twenty-one districts were surveyed. Three areas were found to be quite deficient. Recommendations were made to clean mains and install new fire hydrants, both of which were due. In order to maintain the clean conditions of the mains, a program was started to add Calgon to the mains.

Net Work Analyzer

Victor A. Appleyard, Chief of Water Operations, Water Dept., Philadelphia, Pa. explained the USE OF PIPELINE NETWORK ANALYZER AT PHILADELPHIA. Mr. Appleyard opened his paper with a thumbnail sketch of the Philadelphia Water Works and of the specific multi-million dollar improvement program for the next five years.

These improvements include rebuilding all filter plants, replacing some pumping stations, additional storage facilities, additional trunk main capacity in existing built up areas, new trunk mains, as well as grid systems in newly developed areas, plus a cleaning and lining program

to rehabilitate the older parts of the distribution systems.

With this active program of distribution system reinforcement and improvement the use of the McIlroy Network Analyzer appeared to be a must. An experimental use of the Cornell University Analyzer showed the value of the device so one was purchased and installed in Philadelphia.

Mr. Appleyard explained briefly the original development of the analyzer and the principle on which it works, namely that the flow of electricity follows the same pattern of "head loss" as water flowing through a pipe; i.e. loss of head varies as the 1.85 power vs. flow. Since the analyzer is only as good as the information fed into it, it is necessary to obtain the best data possible.

Mr. Appleyard showed slides of the analyzer at Philadelphia, explained its operation, and told of a specific case in Philadelphia concerning a new residential, commercial and light industrial area. As a result of this study, in approximately two weeks, the final design used smaller pipe than contemplated, thus saving $350,000.

Another use of the Analyzer is for operating problems and Mr. Appleyard explained how the device was

Program

T. R. Wolfe W. D. Monie

used in planning a cleaning and lining program in one high service district. Another use for the benefit of the Operation Department, is to analyze a weak part of the distribution system under normal performance and under maximum load conditions.

Maintaining Pipe Line Coefficients

Wm. D. Monie, Chief Engineer, and Harold B. Scales, Chemist, Portland Water District, Portland, Me. presented a paper on MAINTAINING PIPE LINE COEFFICIENTS (C) AFTER MAIN CLEANING. Mr. Monie described the system studied, some 8000 ft. of main between a booster station and an elevated storage tank for one section of the system. The "C" value was only 50 to 56. Four thousand feet of the line were cleaned and the "C" value went to 122.

To maintain this high value, a program of regular and continuous addition of Calgon was adopted. For the first two weeks 7 ppm of Calgon and 6 ppm of T glass were added, then the dosage was reduced to 5 ppm. A study was made of iron pickup in the line through which water was pumped only 5 hours a day. In effect the line was a dead end for 19 hours a day. Iron pickup averaged 0.1 ppm per hour. By changing the pumping schedule, the dead end time of the line was reduced and although the total iron pickup was about the same, the concentration of iron did not reach undersirable values.

On the basis of this study for several months, the whole line was cleaned and now has a "C" value of 122 and the pumping head required is 43 ft. less than before. The iron loss is calculated to be 0.012 lb per foot per yr, as long as Calgon is added. Mr. Monie said that if the coefficient "C" did not drop below 100 in ten years, he would consider the operation a success. At the present time, Monie and Scales are highly pleased with the results of the program.

"Water is Too Cheap"

John Murdoch, Jr. of Philadelphia (a regular and valued contributor to this magazine) presented arguments in a well developed and realistic manner before the American Water Works Association to prove that public disregard for the real worth of water is basically due to the fact that water utilities have never charged enough for water service to make the average citizen appreciate water as he does electricity and gas—lesser important commodities supplied by public utilities.

Mr. Murdoch decried the fallacy of the boast by water works managers that "Water is cheaper than dirt!". He lamented this kind of salesmanship and its poor psychological effect on the public.

Murdoch's spirited address received more attention in the national press (wire services) than any other presentation during the A.W.W.A. convention in St. Louis. We have no doubt but that Murdoch's pointed talk had some influence on the St. Louis Council which a few days later voted a pay increase to the water works management and water department employees.

We were reminded of the fact that "Water is too cheap" when noting the following in an article in a little magazine enjoying nation-wide distribution to policy holders in a very large general insurance company. The article captioned "A Penny Saved May be a Dollar Spent" contained the following commentary as an example of so called expensive savings.

> "Next time you drop a coin into your piggy bank ask yourself how much *actual* cash it cost to put it there. Is it the 5c you saved on your water bill by paying a plumber $5.00 to fix that leaking fixture?"

We can only presume that the writer of this story was thinking of the boast of the water works industry "Water delivered into your home costs less than 5c a ton!" or "Water is cheaper than dirt!"

Yes, John Murdoch is so right when he proclaims that what ails the water works industry (and always has) is the one underlying obstacle to progress "WATER IS TOO CHEAP!".

Linton Now Two Directors in One

W. T. ("Bill") Linton of Columbia, S. C., who since 1951 has been Executive Director of the South Carolina Water Pollution Control Authority, has recently been made Director of the Sanitary Engineering Division of the S. C. State Board of Health in addition to his duties as director of the Pollution Control Authority.

Mr. Linton, a native of Greensboro, Georgia, received his B.S. degree in Civil Engineering in 1928 and his M.S. degree in Public Health from Columbia University in 1945. His professional career began with the S. C. Highway Dept. from 1928 to 1943. In 1943 he joined the Sanitary Engineering Division of the S. C. State Dept. of Health. In 1951 he was appointed Executive Director of the newly created S. C. Water Pollution Control Authority. On July 15, 1956 he was appointed Director of the Sanitary Engineering Div. of the S. C. State Dept. of Health and henceforth will serve in the dual capacity in charge of all State activities pertaining to water supply, sewage treatment and industrial pollution control.

Sounds like a most logical consolidation of the two offices which of their nature must be over-lapping to a large measure.

If you want to be triumphant, try adding some "umph" to each try.

What's In Our Future?

An open letter from one superintendent to another

Dear Bill

Some months ago I got to dreaming about what our business might be like in the next ten, twenty or thirty years. Oh, I know it's going to be bigger because there will be a lot more people—predicted at 200 million or more by 1975—and the water use per capita will be greater by far than today. Some experts predict 150 gallons per capita per day for domestic use alone—and then there's the growing industrial use. Yes, there's no doubt about it, we're going to have to pump and treat a lot more water and treat and dispose of a lot more sewage. That means bigger plants and longer distribution systems and larger and longer sewers—but, what other changes are in store for us?

I Asked Some Questions

The more I thought about the future, the more I wondered what other people in the business thought. So I sat down and wrote to thirty men whom I believe to be present day leaders in the field. Twenty four replied. Included in the list were consulting engineers, educators, water and sewage works superintendents, editors, state and federal public health engineers, equipment manufacturers and technical association secretaries.

I asked two basic questions: (1) What equipment developments and research are most needed in water works and in sewage works? (2) What equipment or process development do you expect to see in the next ten years?

For the most part, those persons who replied did not differentiate between what is needed and what is to be expected. I had the impression that if they thought some development is needed, they also believe that it will come to pass, but they hesitate to say how soon.

The men who replied to my questions had many ideas and their letters covered topics and subject matter from management to laboratory techniques.

For Water Works

In the field of water works management you can look for several current trends to continue. Water works men and management will become more safety minded and the safety records for the industry will improve.

There will be more trained engineers entering the water works business and the general caliber of employees throughout the industry will improve. That, of course, will mean that higher salaries will be paid. To meet these increased employee costs as well as other charges there will be increased rates based on realistic appraisal of the service. Service to the public will be improved and the era of "too cheap water" will finally end.

Almost certain to come are demand rates based on some new type of demand meter. There will be more efficient office operations through office mechanization and mechanization will be more evident in both construction and maintenance. One other thing—the amount of non-revenue water will be reduced through better leakage control.

When it comes to source of supply we can look for increased use of treated sewage effluents for ground water recharge or re-use by industry. We can also expect to see an economical process for desalting sea water and its wide adoption along the sea coasts particularly for industrial supplies. We may see a return to the idea of the ancient Roman aqueducts. We already have a few canals in this country to transport water from one area to another and we may have more canals or large transmission lines from distant sources of supply to water deficient areas.

We can look forward to smaller more compact treatment units, improved treatment for coagulation, disinfection and tastes and odors, better pre-treatment preparation and clarification, higher filtration rates. We can expect new filtration systems such as micro-straining and diatomite filters probably in combination. We can also expect more butterfly valves in water plants, improved corrosion control through protective coatings. Above all look for more automation, for automatic operation is definitely coming although at the moment we need new and improved sensing elements for automatic control.

Other things to come are plastic linings for mains, plastic pipes for services, and automatic control of the distribution system to provide water where it is needed at any instant. In the laboratory we'll have a new index organism, improved rapid bacteriological methods and more analysis by instruments.

For Sewage Works

For sewage works operation the crystal gazing was no less intriguing. We can look for higher caliber personnel, higher salaries, higher service charges and more efficient office operation. In the sewage laboratory, look for simplified control tests and more analysis by instruments.

We can expect to see smaller treatment units which will accomplish more efficient removal of solids and B. O. D. New types of more efficient trickling filters to operate at high rates, an activated sludge process that has no waste sludge and is highly efficient, or an activated sludge process which uses tonnage oxygen in place of air.

Digestion of sludge will be at high rates anaerobically, or possibly by aerobic processes. Chemical and mechanical dewatering and drying of sludge will become increasingly important in large cities and the processes will be improved. In smaller cities digestion by lagooning will be used. Lagooning of raw sewage will be seen more frequently as will treatment by algae.

No longer will sewage treatment be just an expensive means of getting rid of a nuisance resulting from modern civilization. Recoveries from sewage treatment will help pay for the cost of treatment. Among the products to be recovered, in addition to sludge soil conditioner, are carbon dioxide, methane, fatty acids, nitrates, ammonia, vitamins (even now being recovered), grease, and possibly other items.

We can also look for automatic control equipment to eliminate second and third shift operators. Eventually, we can expect true automation with sensing devices to determine the strength of the sewage and to control process operation, including control of disinfection, oxidation and solids treatment and disposal.

If what these men predict comes true, and I think mostly they will, it looks as though there is a good future, right now, for young sanitary engineers. Don't you agree?

Yours, Ted

WATER WORKS PRACTICES

Disinfection—Part 3

Chlorination Practices; Other Disinfection Methods

The Thirty-fifth of a Series

by GEORGE E. SYMONS, Ph. D.

Dr. Symons is a Consultant and Technical Editor in Larchmont, N. Y. In this series he discusses *Water Works Practices* in the form of short school lectures, designed to assist operators, students and others who wish to review fundamentals in this field.

F . . . Chlorination Practices

1 . . PURPOSE OF CHLORINATION

a. *Disinfection* is the principal function of chlorination but there are other reasons for chlorinating water.

b. *Taste and odor control,* another reason for chlorinating water, has been discussed in a previous lecture.

c. *Transmission line chlorination* may be used on long lines to control the development of biological growths which cause loss of carrying capacity.

d. *Slime control* by chlorination is practiced in process and cooling water systems, particularly in manufacturing and power plants.

2 . . TYPES OF CHLORINATION

a. When chlorine is added to water, it first satisfies the "chlorine demand" and then produces a chlorine residual. The type of residual formed determines the type of chlorination.

b. *Combined residual chlorination* exists when the chlorine residual consists of chloramines produced by the reaction of chlorine and ammonium compounds, either present naturally or added.

(1) Chlorine existing in water in chemical combination with ammonia or organic nitrogen compounds is defined as combined available chlorine.

(2) True chloramines may be monochloramine (NH_2Cl), dichloramine ($NHCl_2$), or nitrogen trichloride (NCl_3) according to these reactions, always with an excess of ammonium ion.

$$Cl_2 + H_2O \rightarrow HOCl + HCl$$
$$HOCl + X\ NH_3 \rightarrow NH_2Cl + H_2O + NH_3$$
$$2HOCl + X\ NH_3 \rightarrow NHCl_2 + 2H_2O + NH_3$$
$$3HOCl + X\ NH_3 \rightarrow NCl_3 + 3H_2O + NH_3$$

(3) Whether one chloramine or a combination is formed depends on the pH of the water and an excess of ammonia.

. . . Above pH 8.5 monochloramine will exist.

. . . Between pH 8.5 and 4.5 a mixture of mono- and dichloramine will prevail.

. . . Below pH 4.4, nitrogen trichloride is produced.

c. *Free residual chlorination* exists when the chlorine residual produced is not combined with any organic or inorganic substance but exists free, as hypochlorite ion or as chlorine in solution.

(1) Chlorine existing in this state is defined as free available residual chlorine.

(2) If no ammonia is present in the water, free residual chlorine will be produced directly by the addition of chlorine to water.

(3) If ammonia is present in water it can be destroyed by the addition of a sufficiently large amount of chlorine and free residual chlorine will be produced.

(4) As increments of chlorine are added to water containing chlorine it is observed that chlorine residuals first increase and then decrease; and then increase again almost in direct ratio to the chlorine added.

. . . This dip in the residual curve (See Fig. 3) is known as the breakpoint; after the breakpoint is passed the chlorine residual is almost wholly free available chlorine residual.

. . . The theoretical amount of chlorine necessary to produce the breakpoint is estimated at from 7.5 to 10 times the ammonia nitrogen content of the water.

. . . In practice, it may require a chlorine dosage of 10 to 25 times the ammonia nitrogen content to reach the breakpoint because of interference of organic matter in the water.

(5) The chemistry involved in the breakpoint involves, first the formation of intermediates, followed by their destruction as the reaction proceeds in the presence of excess chlorine; pH has a definite bearing on the reactions.

. . . At pH 9.0, an excess of chlorine will react with monochloramine (NH_2Cl) to produce volatile free nitrogen (N_2) and nitrous oxide (N_2O) and the residual chlorine will be of the free available type.

. . . At pH 4.5 to 5.0, excess chlorine will react with dichloramine ($NCH1_2$) to produce volatile trichloride (NCl_3) and nitrous oxide (N_2O) but there will also be some ammonia present and the chlorine residual will be predominantly free available chlorine with some combined available chlorine.

. . . Between pH 5.0 and 9.0 combinations of these reactions will take place and the ratio of free to combined chlorine will vary depending on the pH.

(6) If free residual chlorination is

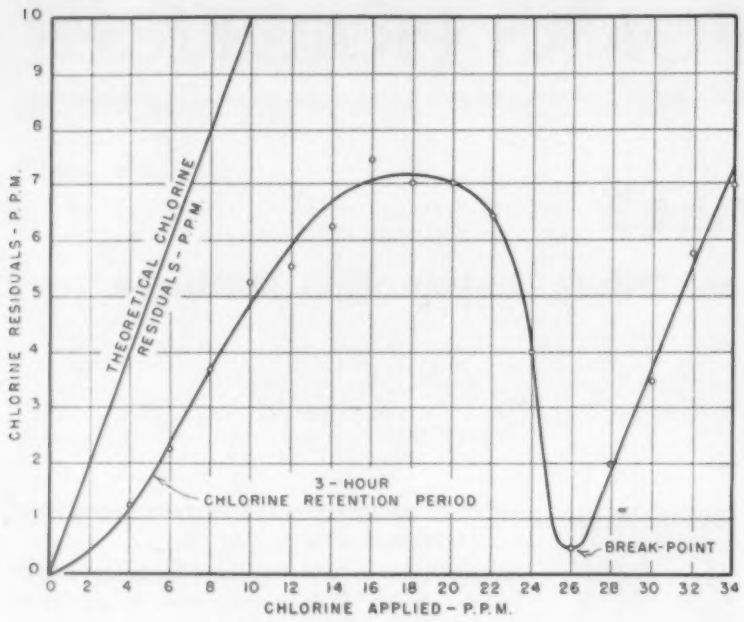

CHLORINE RESIDUALS - P.P.M.
THEORETICAL CHLORINE RESIDUALS - P.P.M
3 - HOUR CHLORINE RETENTION PERIOD
BREAK-POINT
CHLORINE APPLIED - P.P.M.

Fig. 3—Example of breakpoint curve

practiced and the final pH is 8.0 to 9.0, no detectable amount of nitrogen trichloride will be formed, but at lower pH values NCl_3 will be produced and may cause odors (see lecture on Tastes and Odors).

d. *Dechlorination* is the partial or complete reduction of residual chlorine in water by any chemical or physical treatment.

(1) If high chlorine residuals (either combined or free) are produced for the purpose of taste and odor control, for example, it may be necessary to dechlorinate to produce a palatable water.

(2) Dechlorination is frequently accomplished by adding sulfur dioxide as the reducing agent.

$$Cl_2 + SO_2 + 2\ H_2O \rightarrow 2\ HCl + H_2SO_4$$

. . . Activated carbon may be used to dechlorinate

$$2\ Cl_2 + C + 2\ H_2O \rightarrow 4\ HCl + CO_2$$

. . . Granular activated carbon beds may be used following sand filters.

(4) Submerged or spray aeration will remove only a small amount of free residual chlorine, but combined residual chlorine will be removed by aeration if the pH of the water is between 4.5 and 5.0 since the dichloramine predominates in that pH range.

e. Chlorine-ammonia treatment (once termed chloramination) is in effect combined residual chlorination since ammonia is added before the chlorine.

(1) The process first came into use as a means of avoiding chlorophenol tastes and odors, but free residual chlorination is preferred in modern practice.

(2). In order to control the chlorine-ammonia treatment it is desirable to maintain the ammonia chlorine ratio at 3:1 according to theoretical considerations if it is desired to have an excess of ammonia.

. . . The ratio should never be less than 3:1, but at pH of 9.0 the ratio may be 5:1 while at a pH of 5.0 the ratio may be 9:1.

3 . . Points of Application

a. Not only is chlorination classified by the type of residual produced but it is also described by the location of the points of application of the chlorine.

b. Plain chlorination is the application of chlorine to an otherwise untreated water supply either in the pipe leading to the distribution system or to the distribution system itself.

(1) Its sole purpose is disinfection and the safeguarding of the supply.

(2) The chlorine may be added to a gravity flow line or pump suction and the dosage is usually proportioned to rate of flow.

c. *Prechlorination* is the application of chlorine to water prior to any other treatment.

(1) Prechlorination may be helpful in improving coagulation, suppressing the decomposition of sludge in settling basins, in algae control, waste and odor control and in mimizing biological growths on filters.

(2) In gravity systems prechlorination takes place in the pipe line leading to the mixing or settling basin; in pumped raw water supplies, the chlorine may be added to the suction of the pump or at the mixing or settling basin inlet.

(3) Since chlorine contact time is important in disinfection, prechlorination offers longer contact times, but the residual should be maintained through the filters.

(4) If ammonia is added before chlorine, many advantages of prechlorination are lost because the chloramines have lower oxidation potentials than chlorine.

d. *Postchlorination* is the application of chlorine to water subsequent to any other treatment.

(1) Generally, post chlorination follows filtration.

(2) Where prechlorination or coagulation precedes filtration, chlorine added subsequent to these treatments but prior to the filters is termed postchlorination.

(3) When postchlorination follows filtration, the chlorine is usually added to the filter effluent or the clear well influent, in order to give as much contact time as possible; if this is not possible the chlorine may be added to the clear well effluent.

(4) When postchlorination is ahead of the filters but follows prechlorination, this second addition of chlorine helps maintain filter efficiency.

e. *Rechlorination* is the application of chlorine at one or more points in the distribution system following previous chlorine treatment.

(1) The point of application may be at the end of a long feeder line, at some outlying community, or at a booster station.

(2) The main purpose of rechlorination is to maintain an adequate residual in the distribution system and as protection against bacterial pollution of storage reservoirs and tanks.

f. *Transmission line chlorination* is the application of chlorine to the influent of a line or conduit carrying a water supply from an upland reservoir source to a distributing reservoir or to a water treatment plant for the purpose of biological growth control.

4 . . Chlorine Dosage

a. The amount of chlorine (in lb per day) needed at a particular water plant depends on two basic factors, chlorine required (in mg/L) and flow of water to be treated (in mgd), and a number of factors which affect chlorine required.

b. *Chlorine required* is the dosage (in mg/L) of chlorine that must be added to a water to produce the amount and type of residual desired

Courtesy of Proportioneers, Inc.

BATTERY of diaphraghm hypochlorite feeders

and the extent of disinfection desired.

(1) Chlorine required depends on the chlorine demand, pH, and temperature of the water and the chlorine contact time afforded.

(2) Chlorine required is not synonomous with chlorine demand but does bear some relation to it.

c. *Chlorine demand* is defined as the difference (in mg/L) between the amount of chlorine added and the residual obtained under standard laboratory conditions of time and temperature.

(1) "Standard Methods" set the conditions as 20°C, 15 min contact time and a residual of 0.1 mg/L.

(2) Chlorine demand is a measure of the organic matter in water that will react with chlorine under these standard conditions.

(3) Since these standard conditions do not always exist in a plant, it is obvious why chlorine demand and chlorine required are not the same.

d. The relation between chlorine required and extent of disinfection depends on the type of residual.

(1) For complete destruction of bacteria (sterilization) it may require 25 times as much combined available residual chlorine as free available residual chlorine.

(2) Likewise combined available residual chlorine may require 100 times as long to produce 100 per cent kill as the same amount of free available residual chlorine.

(3) For water supplies not highly contaminated the dosage normally will not exceed 2 mg/L.

e. Chlorine feed rate for feeders (in lb per 24 hr) is calculated as follows:

Dosage (mg/L) x Flow (mgd) x 8.34 = Feed Rate (lb/24 hr)

5 . . Control of Chlorination

a. Control of chlorination is based on tests for residual chlorine.

(1) If the chlorine required is not known it can be determined approximately by determining the chlorine demand and adding approximately 0.2 mg/L to the dosage.

(2) Calculation of the feeder setting can be made according to the formula above or from a chemical control nomogram (See Fig. 2 in lecture on Chemical Handling and Feeding).

b. Residual chlorine can be determined by iodometric titration, by amperometric titration, or colorimetrically.

(1) The most common method is the orthotolidine test.

(2) If an operator desires to differentiate between combined and free available residual chlorine, the orthotolidine-arsenite test is used.

(3) Directions for making these tests are given in Standard Methods for the Examination of Water, Sewage, and Industrial Wastes.

c. Instrumental determination of chlorine residual by amperometric titration is possible with a commercial device which records the residual chlorine content continuously. It serves as a continuous monitor on the chlorination treatment.

Relation of Residual and Contact Time for 100 Per Cent Bacterial Kill*

pH Range	Free Residual Amount	Time	Combined Residual Amount	Time
6.0- 7.0			1.0	60 min
7.0- 3.0			1.5	60 "
6.0- 8.0	0.2	10 min		
8.0- 9.0	0.4	10 "	1.8	60 "
9.0-10.0	0.8	10 "		
10.0	1.0	10** "		

*From Butterfield JAWWA, 40:1305 (1948)
**Use lower residual for up to 4 hr. contact

G . . . Hypochlorination

1 . . Chemicals Used

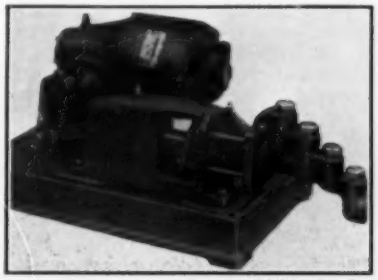
a. Before the advent of liquid chlorine, chlorination was accomplished by adding chlorinated lime (bleaching powder) to water.

(1) Chlorinated lime, a loose combination of slaked lime and chlorine gas, has the approximate composition ($CaOCl_2$).

(2) In the presence of water it will decompose to give calcium hypochlorite ($Ca(OCl)_2$).

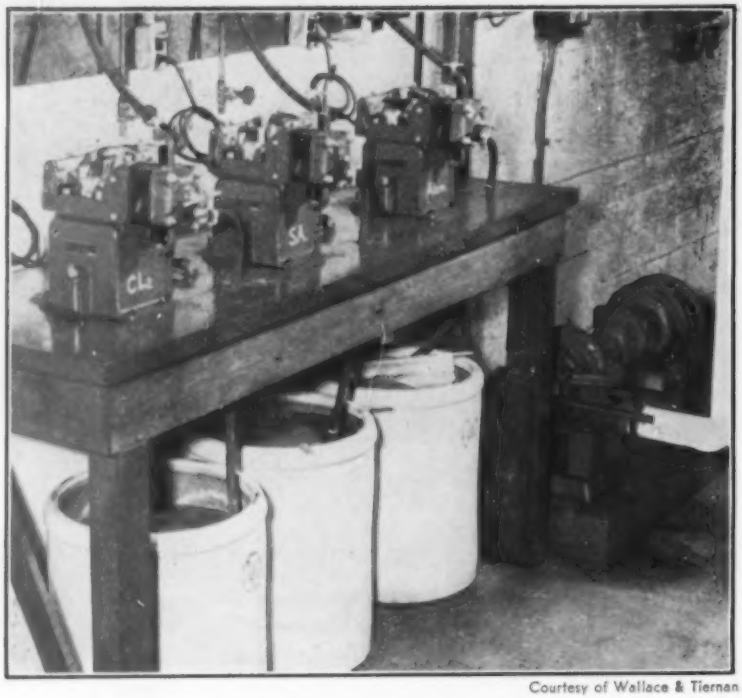
(3) Chlorinated lime, seldom used today, usually tests 35 to 37 per cent *available chlorine**, when fresh.

* The term *available chlorine* is a misnomer. It is based on the false concept that the concentration of chlorine in a hypochlorite solution is measured by the amount of iodine it will displace from a solution of potassium iodide on the basis that one atom of chlorine will displace one atom of iodine. Actually, one molecule of calcium hypochlorite will liberate four



Courtesy of Milton Roy Co.

POSITIVE displacement piston type chemical feeder



Courtesy of Wallace & Tiernan

DIAPHRAGM type chemical feeders
Hypochlorite, soda ash, alum

b. Modern high test calcium hypochlorites are not only twice as strong as chlorinated lime but retain their original strength for more than a year under normal conditions. They may be obtained in granular or tablet form.

c. Sodium hypochlorite solution (Na OCl) usually contains about 15 per cent available chlorine in the commercial product. (Household bleach solutions of sodium hypochlorite usually contain only 3 to 5 per cent available chlorine).

2 . . USES OF HYPOCHLORITES

a. Hypochlorites find their greatest use for small surface and well supplies, swimming pools, for disinfecting mains and for emergency use in water supplies contaminated by flood waters etc.

b. When granular hypochlorites are used they are dissolved in water and fed by a chemical feeder, usually a positive-displacement solution pump which utilizes either a diaphragm or piston as the pumping element.

c. In tablet form a special tablet hypochlorinator which stores a supply of tablets, dissolves the tablets, measures and controls the rate of feeding and feeds the hypochlorite solution to the point of application.

d. Dosage tables have been prepared by various manufacturers showing how to prepare different strengths of solution and how much each solution strength is needed to obtain the desired treatment of different volumes of water.

H . . . Main Disinfection

1 . . PURPOSE

a. Mains are likely to become contaminated during laying procedures in spite of all precautions and therefore newly laid mains must be disinfected before they are put in use.

b. Distribution systems may also become contaminated in the event of floods or main breaks.

2 . . STANDARD PROCEDURE

a. The Amer. Wat. Wks. Assn. has developed "A Standard Procedure for Disinfecting Water Mains—AWWA C601-54".

b. Outline of procedure

(1) Thorough flushing is the first step.

(2) Chlorinate with chlorine or chlorine-water, calcium hypochlorite (HTH, Perchloron, Pittchlor), sodium hypochlorite solution or chlorinated lime water solution.

(3) Apply chlorine at one extremity of the pipe section and bleed at opposite end; take precaution that chlorinated water does not enter potable supply.

(4) Inject chemical through corporation cock, venting all high points on line for air escape.

(5) The rate of chlorine application should be enough to produce a residual of at least 25 mg/L at the end of the line being treated; sometimes higher doses are necessary.

(6) Allow the line to be subject to chlorine for at least 24 hr. at which time the water at the end of the line should show at least 10 mg/L of residual chlorine.

. . . If shorter contact periods are used, the chlorine dosage should be 50 to 100 mg/L.

(7) Calculation of the dosage can be made from the gallonage capacity of the pipe line to be treated.

. . . The amount of hypochlorite or chlorine required is determined from the selected chlorine dosage, the available chlorine content of the chemical and the bleed rate.

. . . A "Water Main Sterilization" chart, with accompanying directions, is available as Keep Sheet No 12A from B-I-F Industries, Inc. This nomographic chart makes calculations of dosages, pipe line capacity and bleed rate a simple process of alignment of various scales.

(8) Equipment may consist of a chlorine gas feeder if chlorine gas is used or positive displacement chemical feeder which can be operated proportionally to flow, powered from the main itself through a disc meter installed on a temporary bypass around a gate valve which segregates the line under treatment.

I . . . Other Disinfection Methods

1 . . CHLORINE DIOXIDE

a. When sodium chlorite ($NaClO_2$) is acted on by chlorine (or by hypo-

(Footnote continued from preceding page)
atoms of iodine from potassium iodide.

The term *available chlorine* therefore is a measure of the total oxidizing power of the chemical being tested and is equal to the (OCl^-) value or twice the weight of the chlorine present as (OCl^-) in the compound. *Available chlorine* is determined by titrating the iodine released by the hypochlorite from an acidic solution of potassium iodide and is calculated as percentage by weight of the original substance.

Some calculated theoretical available chlorine contents of various chlorine containing compounds are:

Chemical	*% Available Chlorine*
Chlorinated lime (impure Ca (OCl)Cl)	35.0
Calcium oxychloride (Ca(OCl)Cl)	56.0
Commercial high test hypochlorites	70.0
Sodium hypochlorite (NaOCl)	95.4
Calcium Hypochlorite $Ca(OCl)_2$	99.2
Chlorine	100.0
Technical sodium chlorite (82% $NaClO_2$)	130.0
Hypochlorous acid (HOCl)	135.6
Chlorine dioxide (ClO_2)	263.0

chlorite in the presence of acid) a powerful oxidizing agent, chlorine dioxide (ClO_2) is produced.

b. Chlorine dioxide treatment was first introduced for the treatment of tastes and odors, particularly phenol, but it is also highly effective as a disinfectant, since it will produce a free available chlorine residual.

2 . . Ozone

a. Ozone (O_3) is produced by brush discharge of high voltage electricity between stationary electrodes, through dry air in a closed apparatus termed an ozonator.

(1) About 1 per cent of the oxygen in the air is converted to ozone.

(2) Ozone is a faintly blue gas of pungent odor.

b. There are three methods of bringing ozonized air into contact with water.

(1) Spray water into atmosphere of ozone.

(2) Discharge ozonized air into a scrubber.

(3) Diffuse ozonized air into a contact tank through injector or porous media.

c. Most ozone installations are in France and other European countries.

(1) Results there indicate effective disinfection.

(2) The problems of cost of installation and operation have held back acceptance of the method in the United States but this situation may change under the pressure of commercial development and promotion efforts.

3 . . . Bromine

a. Bromine is a member of the halogen group, as is chlorine, and has a bactericidal action, which however, is less than that of chlorine.

b. Bromine was used principally for the treatment of swimming pools when first proposed for disinfecting water. It has never been adopted for drinking water treatment.

4 . . . Iodine

a. Iodine, also a member of the halogen group, may be used to disinfect small amounts of water.

b. Eight (8) mg/L is the recommended dosage for 10 to 15 min. contact.

5 . . . Ultraviolet Light

a. Mercury vapor under the influence of electricity in a quartz lamp will give off ultraviolet light rays and these rays are bactericidal.

b. Where this method of disinfection is applied, the water flows in a thin film past a series of quartz mercury vapor arc lamp; the series of lamps being required to provide exposure time.

c. Maximum film thickness is about 120 mm and the water can have no more than 15 ppm of color.

d. Most installations have been for swimming pools, surgical uses, fermentation process waters, and in bottling plants. The Hanovia Steritron is one commercial unit in use today.

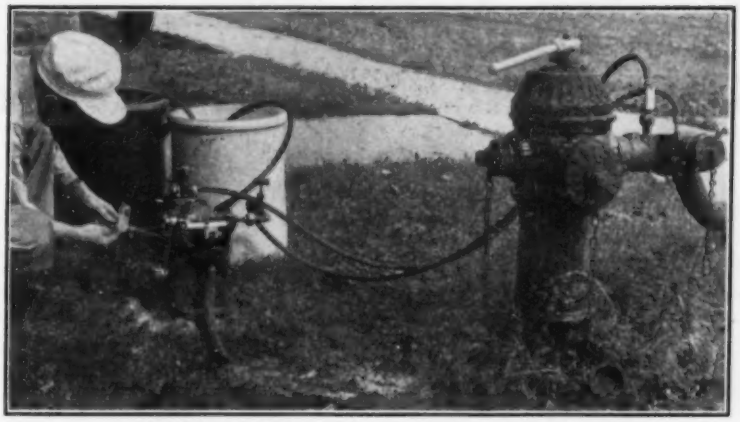
e. The cost of installation and operation appears to weigh heavily in the possible application of ultraviolet light disinfection of municipal water supplies.

6 . . Silver Compounds

a. The oligodynamic action of minute amounts of certain metals is well known in bacteriology.

b. Bacteria exposed to colloidal silver particles will die, but the disinfecting action varies with different bacteria and with exposure time.

c. The treatment has been promoted several times in the last several decades but its acceptance has not been appreciable The latest commercial product is Movidyn.



HYPOCHLORITE feeder arrangement for main disinfection

J . . . References

Material for this lecture was obtained from the following reference texts as well as articles in the technical journals and magazines.

AWWA—"Manual of Water Quality and Treatment", 2nd Ed., Chap. 9. (Am. Wat. Wks. Assn.)

B-I-F Industries, Inc.—Keep Sheets No. 12A, 13, 19, 21, and 25.

Buswell,—"Chemistry of Water and Sewage", ACS Monograph No. 38.

Fair & Geyer—"Water Supply and Waste Water Disposal", Chap. 27, (John Wiley & Sons)

Prescott, Winslow and McCrady—"Water Bacteriology" 6th Ed. (John Wiley & Sons)

Standard Methods for the Examination of Water, Sewage and Industrial Wastes, 10th Ed.

NEXT LECTURE—Chemistry of Water

— CORRECTION —

Prof. F. W. Macdonald of Tulane University has called our attention to certain errors which appeared in "Disinfection--Part 1", published in the Sept. issue of *Wat. & Sew. Wks.*

Page 411 - Col 2; item A-1-d-(2) -- the names of the cities, Hamburg and Altona are interchanged; it was Hamburg which had the severe cholera epidemic and Altona which had the filtered supply. (Note too, the name Altona was misspelled).

Page 412 - Col., item A-3-a-(1) -- should read, "Amebic dysentery (amebiasis) is caused by Endamoeba histolytica.... (The name of the organism was misspelled.)

"SOME fire-hydrant salesman, I'll bet!"

N. Y. Sect. AWWA Discusses

Distribution System Problems

MORE THAN 400 persons, including a goodly number of wives, registered at the N. Y. Section AWWA meeting, held at the Sagamore Hotel ,Bolton Landing, N. Y., on Lake George, Sept. 12-14. Except for a boating accident in which two persons were burned, the meeting was highly successful, with the technical program being devoted almost entirely to the subject of distribution systems.

F. D. Behan

L. J. Griswold

Kim. Blanchard

Officers

Water Works School

At each of the two annual meetings, for the past three years, a Water Works School has been held on the opening morning, under the leadership of Dr. George E. Symons, Consultant and Technical Editor of Larchmont, N. Y. These sessions are conducted as schools, with the speakers presenting lectures, followed by a "class room" discussion period; no formal papers are read. Attendance at these sessions has been excellent and this particular session drew more than 125 "students". All six of the sessions to date have been on the subject of distribution systems and the interest in the subject has been such that this general topic will continue to be discussed.

W. T. Ingram

J. G. Copley

Lecturers

Main Extensions

The particular topic for this meeting's Water Works School was MAIN EXTENSIONS. In opening the session, Dr. Symons pointed out that the subject is important not only to large communities but also to small ones. General interest in main extensions is evidenced by the number of papers that were published on the subject last year; two from Canada, one in New England, one by ASCE, one from Iowa, etc. This session approached the topic from two points of view: (1) "Fundamental Concepts and Policies" and (2) "Modern Practices."

Speaking on FUNDAMENTAL CONCEPTS AND POLICIES, Wm. T. Ingram, Consulting Engineer, and Adjunct Professor at New York University said, "No water system can be developed or carried forward unless there is a master plan for the ultimate future." No water works superintendent should trust to memory; both plans and operations should be committed to record.

Whether a town has an old or a new system, any plans for the future must include a hydraulic study of the system; a study which will reveal or predict what future flows will be and where and how they should be handled. It is necessary to know how many people may be expected to reside in the community, where those people may be expected to live and what will be the density of population per acre. It makes a big difference whether new residents are in one house per acre or in apartments where the density may be 500 per acre. Mr. Ingram believes that water works men should work with planning boards to establish zones of residence so that some realistic planning and forecasting of water use will be possible. In such plans it is necessary to estimate the baby crop.

When planning future extensions to fringe areas, plans should be made to install the size of pipe needed for service 20 years from now—"don't install a 6 or 8 in. pipe when you will need a 16 or 20 in. pipe in the future." In making this statement, Mr. Ingram said he realized that it was difficult to convince people today that they should pay for future needs.

As to the matter of a hydraulic study, Mr. Ingram admitted that it was not easy to make, but without such a study and the plans developed therefrom, subdividers will run the water works extension policy. One of the factors to be developed is: How much water will be needed to satisfy the water demand, for not only does population increase, but the per capita consumption also increases. As long as people will pay for it, water demand should be met according to Mr. Ingram, and the utility should provide both the service and the water without limitations. Where one has a flat rate service, the water supplied is subject to what you can provide, but where services are metered, the utility should provide what water is asked for.

In making plans for the future, cognizance must be taken of the possible fire demands, which require both storage and distribution facilities. The water superintendent must consider the NBFU requirements and decide how well he can afford to meet these requirements and how many penalty points he can afford to accept for his community.

Not only is long range planning essential, but frequent revisions of long range plans is necessary and schedules of immediate construction, or that for the immediate future, should always be in current working order.

H. E. Jordan

Presiders
Geo. E. Symons

A. D. Henderson

Modern Practices

On the matter of MODERN PRACTICES IN MAIN EXTENSIONS, John G. Copley, Gen. Mgr., Elmira Water Board, Elmira, N. Y., said there are three specific problems; that of the consumer's service line, that of the fringe customer, and that of the developer. In each case, the methods of practice vary with the problem.

Referring to the first problem, that of the customer's service line, Mr. Copley said there are five questions which arise: Who pays for the work, who does the work, how big is the service, what materials should be used, and what standards must be adhered to.

For customer service, the customer usually pays. Fixed fee billing is frequent but may not pay for the costs of the service. Use of the actual cost basis is better but may require explanations to the customer.

In every case, according to Mr. Copley, the utility should do the work, rather than let the customer have it done by private contractor.

The size of the service should be large enough to meet the demands of modern living. Not only have we more modern conveniences and appliances that use water, than did the last generation, but the pattern of modern living is different. Now, peak demands may come in the evening rather than between mid-morning and noon. Housewives leave dishwashing and even clothes washing and drying until evening when the man of the house returns and bathes, washes the car, or sprinkles the lawn etc. No longer is a half inch service large enough—on either side of the meter.

Materials used for services may be lead, copper, or plastic. At present, plastic pipes vary and they have not yet been accepted by AWWA Specifications. No doubt plastic pipes will come more and more into use and specifications may be expected.

When it comes to fringe area service, it is often necessary to lay mains of 12 or 16 in. size for future use, whereas, a 6-in. line is all that is necessary at the present time. In this case, said Mr. Copley, the customers in the fringe area are billed on the basis of the actual cost of laying a 6-in. line, pro-rated over 20 years.

In the case of developments, usually the developer pays for the mains laid and is repaid to 80 per cent of the cost out of income over a period of years.

In the discussion period which followed questions and answers piled on one another and were still coming when the meeting had to be adjourned for lunch. Among the questions raised was: If the source of supply is limited how can a utility give the consumer all the water he wants. This question evoked a number of replies from suppliers and consumers, with the suppliers wishing to limit water consumption and the consumers wanting all they desire as long as they are willing to pay for it. Harry E. Jordan, Secy. of AWWA suggested that one answer is to charge for water on a demand rate basis, with higher rates for luxury uses of water rather than lower rates as water consumption increases on individual services.

Also discussed from the floor were changes in the practice of the Jericho Water District on Long Island, where developers now have to put up $100 per house for a source of supply fund; this is refunded over a 10 year period. Robt. Austin of the N. Y. State Public Utilities Commission spoke on recent practices in regards to private utilities and Mr. Olmstead Counsel to the Erie County Water Authority explained the practices with respect to developer and main extensions, under that Authority.

Valve Forum

The Thursday afternoon session was devoted entirely to papers on valves. In the absence of Frank C. Amsbary, the session was led by Harry E. Jordan, Secretary, AWWA.

Automatic Valves

Wm. F. End, Jr., Ross Mfg. Co. presented a paper on AUTOMATION AND AUTOMATIC VALVES and pointed out that the efficiency of modern plants depends on automatic control. Among the automatic valves which Mr. End mentioned and discussed were: Altitude and float valves, pressure reducing valves, back pressure valves, distributing-pressure and bypass relief valves, pump control valves, surge arresters, check valves, and combinations.

Kenneth Carl of the Nat. Bd. of Fire Underwriters commented that more automatic control is coming in the future; therefore water utilities must plan to give automatic control equipment the maintenance attention it will require. Mr. Carl also said that with respect to the problem of zones of pressure, systems need more than pressure regulators, for zones create problems of dead ends.

Before introducing the next three speakers Mr. Jordan pointed out that although only three kinds of valves were to be discussed, the choice of those three had no bearing on the program chairman's preferences. Mr. Jordan said that in addition to the gate, butterfly and cone valves scheduled for the program, there are sluice gate, needle, globe, and particularly lubricated plug valves which see wide service in distribution systems.

Gate Valves

LeRoy J. Evan, Vice Pres., Mueller Co., read a paper on GATE VALVES and illustrated his talk with a number of slides showing the various features and different types of valves. For the most part these slides were sketches and drawings or line diagrams. In

Valve Men
W. F. End, Jr. L. J. Evans D. W. Hopkins G. Holdridge

addition to showing the types and features of gate valves, Mr. Evans told some of the history of the gate valve, its advantages, its disadvantages, and methods of classifying the valves as to body, type of stem, gate and seating systems, and stem seals.

Butterfly Valves

D. W. Hopkins, Chief Consultant, Valve Division, S. Morgan Smith Co. York, Pa. spoke on BUTTERFLY VALVES and showed slides of most of the valves of this type made by S. Morgan Smith Co. Mr. Hopkins reviewed the development of the AWWA specifications for butterfly valves (C-504-54T for rubber seated valves and C-505-55T for metal seated valves) and explained some of the differences. He also explained the various kinds of torque which determine the design and operation of butterfly valves. By means of a chalk talk he explained fluid dynamic torque, bearing torque and seating torque, the differences between them, and how they act together.

Cone Valves

Gordon Holdridge, Chapman Valve Mfg. Co., Indian Orchard, Mass., spoke on CONE VALVES. He had no slides but described the design and working of cone valves and explained how they are used for manual use for pipe line shut-off in distribution systems, for check valves, for pressure regulating, for pipe line isolating, and for liquid level control.

Following the formal presentations there was a floor discussion of various valves and their applications.

Round Table

Under the leadership of Angus D. Henderson, Consulting Engineer of Westbury, Long Island, N. Y., the annual ROUND TABLE DISCUSSIONS was held on Friday morning. Four questions were taken up for general discussion:

1. Do you use pressure reducing valves on house services? When?
2. Is your system troubled with air in the water? What do you do about it?
3. Have you used cut-in sleeves for installing new valves and fittings?
4. How do you handle a complaint of illness believed to be due to contaminated water supply?

Local Arrangements

The local arrangements committee was headed by Garner C. Tripp, Supt., Glens Falls. Chairman of the Section for this year is Frank D. Behan, Supt., Plattsburgh, N. Y., Secretary is Kimball Blanchard, Rensselaer Valve Co., New York City. A cocktail party was held on the porch of the hotel through the courtesy of the Water & Sewage Works Mfrs. Assn. The next meeting will be held April 10-11-12, 1957 at Elmira, N. Y.

A Look Ahead at Nation's Sewage Works Needs

Expenditure for Next 20 Years Estimated at $22 Billion Plus

Capital investment of $14.1 billion to increase public sewerage system facilities and $8 billion of expenditures to offset obsolescence and wear will be needed over the next 20 years to provide for adequate service in collection and treatment of sewage for the expanding population of the United States, according to the Water and Sewerage Industry and Utilities Division of the Business and Defense Services Administration, U. S. Department of Commerce,* Washington, D. C.

Present capital investment in public sewerage system facilities is estimated at $19.9 billion. The required capital outlays will increase this figure to an estimated $34 billion by the end of 1975.

Information collected by the Division from all available sources indicates that many inadequacies exist, particularly in sewage treatment plant facilities needed for present standards of treatment to abate stream pollution. To provide fully for adequate collection and treatment would require the estimated expenditure of $5.8 billion.

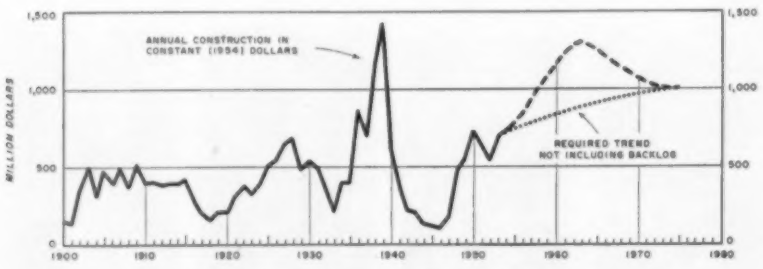
Further expenditure $8.3 billion will be required over the 20-year period to expand these public sewerage facilities to the extent estimated to be sufficient to serve the population growth with its increased rate of water usage, and to maintain appropriate control of stream pollution.

The Division's estimates are based upon an increase in population residing in the United States from about 164.6 billion in 1955 to 206.6 billion in 1975. Of the 1975 population, it is estimated that 163 million will live in communities, compared with 126 million in 1955. The population served by public sewerage systems in 1975 is expected to approximate 134 million, an increase of 34 million over the estimated population served today.

The Division's summary covers the growth of public sewerage systems with respect to value, population served, and annual construction since 1800, with an estimated projection to 1975.

Copies of the "Summary of Information on Public Sewerage Systems—Capital Investment Values",* are available at the Sales and Distribution Branch, Office of Administrative Operations, Department of Commerce, Washington 25, D. C., and the Department of Commerce Field Offices. Price 10c.

*A report based on information gathered, classified and compiled by Walter L. Picton and A. T. Levie of the Water & Sewerage Utilities Division.



Estimated Annual Construction Costs in 1954 Dollars

(Note effect of World War II 1940-45; Korean incident 1950-52)

A Texas Definition

CRUDE: That which, if you've got wells producing enough of, you can get away with being.

Toxicity of Six Chemical Compounds To Thirty Cultures of Algae

by THOMAS E. MALONEY and C. MERVIN PALMER

This article reports an evaluation of algicides through extensive tests on algal cultures. These are some of the latest tests carried out at the Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio, where the authors are associated with the Interference Organisms Studies of the Water Supply and Purification Program.

IN WORK previously reported[11], a method was developed for the preliminary screening of potential algicides. In that screening procedure, various chemical compounds were tested at concentrations of 2 ppm to determine their toxic effects upon six representative species of algae. The purpose of that work was to develop a method for rapidly evaluating the relative toxicity of a number of chemical compounds to algae so that more extensive tests could be carried out with those compounds that gave indications of having either a highly selective or general toxicity.

The work presented herein describes the more extensive tests carried out with six of the chemical compounds that showed the most promise as algicides in preliminary tests. These studies were designed to indicate the lowest concentration of each chemical which could control algae, whether it was selective or general in its algicidal effects, and its toxicity to fishes.

Methods and Materials

The six chemicals selected for testing were copper sulfate, 2, 3- dichloronapthoquinone, dodecylacetamido dimethyl benzyl ammonium chloride, rosin amine D acetate, rosin amine D sulfate, and zinc dimethyl dithiocarbamate.

Copper sulfate was chosen because of the general toxic effects it displayed in the preliminary screening tests, its present widespread use as an algicide, and its value as a baseline for evaluating other materials.

Both rosin amine D acetate (RADA) and rosin amine D sulfate (RADS) displayed general algicidal properties in the preliminary screening. These two compounds are derivatives of rosin amine D, a primary amine. RADA is a technical grade of dehydroabietylamine acetate. It has been reported as effective in controlling *Compsopogon*, a freshwater red alga, in irrigation ditches in Arizona[2] and *Pithophora*, a filamentous green alga, in farm fish ponds in Alabama[9]. However, less satisfactory results were obtained with RADA in later attempts to control *Pithophora* in two Alabama lakes[1].

The three other compounds were chosen because in the screening tests they appeared to be selectively toxic to certain groups of algae[11]. Dodecylacetamido dimethyl benzyl ammonium chloride (DAC) had indicated selective toxicity to the green algae, zinc dimethyl dithiocarbamate (ZDD) to the diatoms, and 2, 3-dichloronaphthoquinone (2, 3-DNQ) to the blue-green algae and diatoms.

The first of these three compounds is a quaternary ammonium compound, some of which group have been reported as being effective in controlling algal growth in cooling towers[12] and open air swimming pools[3]. The second compound is an active ingredient of many commercial fungicides used in orchard and vegetable spraying and as a textile preservative[4]. The third of these, a quinone derivative, has been reported as being selectively toxic to bloom-forming blue-green algae[7].

The first series of experiments reported here was to determine for each compound the minimum concentration required to prevent the growth of various algae. An arithmetical series of concentrations from 0.004 to 32.0 ppm. of active ingredients was tested for each of these six compounds.

For copper sulfate the active ingredient was considered to be $CuSO_4.5H_2O$. The RADA used was 50 per cent active material in solution with 39 percent water and 11 percent isoproponol. The RADS was in the form of a wettable powder with 75 percent active ingredient. The ZDD was 99 percent active, and the remaining two compounds were 100 percent active material.

Three of the compounds, 2, 3-DNQ, RADS, and ZDD, were difficult to disperse in water and it was necessary to employ a laboratory blender to obtain a homogeneous suspension.

Cultures of the 30-algae listed in Table 1 were used as test organisms. Each of these cultures was unialgal; that is, it contained only a single species.

The procedure employed followed closely that used in the preliminary screening tests[11] with the exception that fourteen different concentrations of each chemical were used rather than one, and each of these concentrations was tested against thirty rather than six different cultures of algae. The culture medium approximated Gerloff's modification of Chu No. 10 with the amount of the nitrate doubled[8]. The pH of this medium ranged from 8.0 to 8.9 and the total alkalinity and versenate hardness from 45 to 50 ppm.

Each of the test flasks was incubated at a constant temperature of 72° F. and was illuminated with fluorescent lighting of 140-foot-candle intensity[10]. During incubation the amount of visible algal growth was recorded at intervals of 4, 7, 14, 21, and 28 days.

The presence of algal growth was determined visually, and the amount of growth in each flask was compared to that in the positive control flask. The growth was recorded as being "normal" when that in any particular concentration of the test chemical was the same as that in the control flask, as "partial" when less than that in the control flask, and "none" when no growth was visible. To determine the degree of reproducibility of the results of these tests, six of the test algae were retested in duplicate in each of

TABLE 1

Test Algal Cultures

Blue-green algae:

1. **Calothrix braunii** Bornet and Flahault
2. **Cylindrospermum licheniforme** (Bory) Kuetzing
3. **Microcystis aeruginosa** (Kuetz.) Elenkin
4. **Nostoc muscorum** C. A. Agardh
5. **Phormidium tenue** (Menegh.) Gomont
6. **Plectonema nostocorum** Bornet
7. **Symploca erecta** Pevalek

Green algae:

8. **Ankistrodesmus falcatus** (Corda) Ralfs
9. **Ankistrodesmus falcatus** variety **acicularis** (A. Braun) G. S. West
10. **Chlamydomonas communis** Snow
11. **Chlamydomonas paradoxa** Pascher
12. **Chlorella variegata** Beyerinck
13. **Chlorococcum botryoides** Rabenhorst
14. **Chlorococcum humicola** (Naeg.) Rabenhorst
15. **Coccomyxa simplex** (Pringsheim) Mainx
16. **Coelastrum proboscideum** Bohlin
17. **Gloeocystis gravillei** (Berk.) Drouet and Daily
18. **Mesotaenium caldariorum** (Lagerheim) Hansgirg
19. **Oocystis lacustris** Chodat
20. **Oocystis marsonii** Lemmermann
21. **Scenedesmus basiliensis** Chodat
22. **Scenedesmus obliquus** (Turp.) Kuetzing
23. **Sphaerella lacustris** (Girod.) Wittrock
24. **Stigeoclonium nanum** Kuetzing

Diatoms:

25. **Achnanthes linearis** W. Smith (Strain No. 1)
26. **Achnanthes linearis** W. Smith (Strain No. 2)
27. **Gomphonema parvulum** (Kuetz.) Grunow
28. **Nitzschia palea** W. Smith (Strain No. 1)
29. **Nitzschia palea** W. Smith (Strain No. 2)
30. **Nitzschia palea** W. Smith (Strain No. 3)

the fourteen concentrations of the six compounds.

Bioassays were made with each of these six chemical compounds to obtain some information as to their relative toxicity to aquatic life. These tests were of a preliminary nature and should be considered only as such. The procedure for these tests followed closely the methods proposed by the Subcommittee on Toxicity, Section III, Federation of Sewage and Industrial Wastes Associations[8]. The test animal was the fathead minnow, *Pimephales promelas*. Four fish were used for testing each chemical concentration, two fish in a duplicate series each containing two liters of the concentration.

The experimental dilution water was prepared by mixing 10 percent of a hard spring water with 90 percent of distilled water. The pH, total alkalinity, and versenate hardness of this prepared water approximated those of the culture medium used in the algal toxicity tests. The dilution water was pre-aerated so that at the beginning of the experiment the dissolved oxygen (DO) content was at least 7.0 ppm. Observations were made at intervals of 24, 48, and 96 hours. Values for the median tolerance limit (TL_m) were calculated for each of these intervals and are recorded in Table 4. The TL_m-value is that concentration at which 50 percent of the test fish survived. Also included in Table 4 are the pH, DO, total alkalinity, and versenate hardness of the solutions tested at the beginning of each test.

Results

The toxicities of the six compounds under study to each of the thirty species of algae are listed in Fig. 1 and Tables 2 and 3. Figure 1 indicates the extent of normal and partial growth for each species of alga under test. The darkened portions of the bars of the chart indicate normal algal growth; the undarkened portions indicate restricted algal growth. Table 2 shows the percentages of the total number of species under test which were controlled by concentrations of 2, 1, 0.5, and 0.25 ppm. of each of the six chemical compounds.

In Table 3 the six compounds are ranked in the order of their toxicity to each alga and the three main groups of algae. The most toxic of the six compounds to a particular alga was assigned the number 1; the next most toxic, the number 2; etc. In the event two or more compounds in the same concentration were equally toxic to an alga, the sum of their given number was averaged and that average assigned to each. The ranks under each compound are totalled for each of the three major groups of algae and for all thirty cultures of algae.

While the relative toxicity can be obtained from Table 3, the concentration at which any of the compounds were toxic to a particular alga can be found by referring to Fig. 1. The compound having the lowest total for any of the three groups of algae is the most toxic to that group and that having the lowest total for all thirty cultures is the most toxic to the entire group of algae tested.

All of the tables and the figures are based on the results at the fourteenth day of incubation, because in general the readings were most representative at that time. During this period of incubation the growth curve tends to reach a plateau, and few changes occur with additional incubation.

It is evident from Fig. 1 that all of the compounds exhibit some degree of selectivity to the various species of algae. The selectivity appeared less evident with the diatoms than with the blue-green and green algae, but this may be due to the fact that only three genera and species of diatoms were studied. The difference in the effect upon two to three strains of the same species proved to be small.

Copper sulfate showed greater selectivity toward the algae than did most of the other compounds. Four algae required more than 4 ppm. of copper sulfate for control, these being the blue-green algae *Calothrix braunii* and *Symploca erecta*, and the green algae, *Ankistrodesmus falcatus* variety *acicularis* and *Scenedesmus obliquus*. Only four species of algae were controlled by 0.5 ppm. This is

TABLE 2

Percentages of Species of Algae Controlled by Each Compound

Compounds Tested	Conc., ppm.	Percentage of Species Controlled: Blue-Greens (7 species)	Greens (17 species)	Diatoms (6 species)	All Species (30 species)
Copper sulfate ($CuSO_4.5H_2O$)	2.00	57	35	100	53
	1.00	43	29	50	37
	0.50	28	0	33	13
	0.25	0	0	0	0
2, 3-Dichloro-naphthoquinone (2, 3-DNQ)	2.00	43	6	83	30
	1.00	43	0	17	13
	0.50	28	0	0	7
	0.25	0	0	0	0
Dodecylaceta-mido dimethyl benzyl ammonium chloride (DAC)	2.00	100	76	100	87
	1.00	57	59	100	67
	0.50	14	29	33	27
	0.25	14	0	0	3
Rosin amine D acetate (RADA)	2.00	100	82	100	90
	1.00	86	47	100	67
	0.50	57	18	100	43
	0.25	14	12	50	20
Rosin amine D sulphate (RADS)	2.00	86	53	100	70
	1.00	57	29	100	50
	0.50	28	24	67	33
	0.25	0	0	67	13
Zinc dimethyl dithiocarbamate (ZDD)	2.00	100	88	100	93
	1.00	86	47	100	67
	0.50	57	35	100	53
	0.25	43	18	100	40

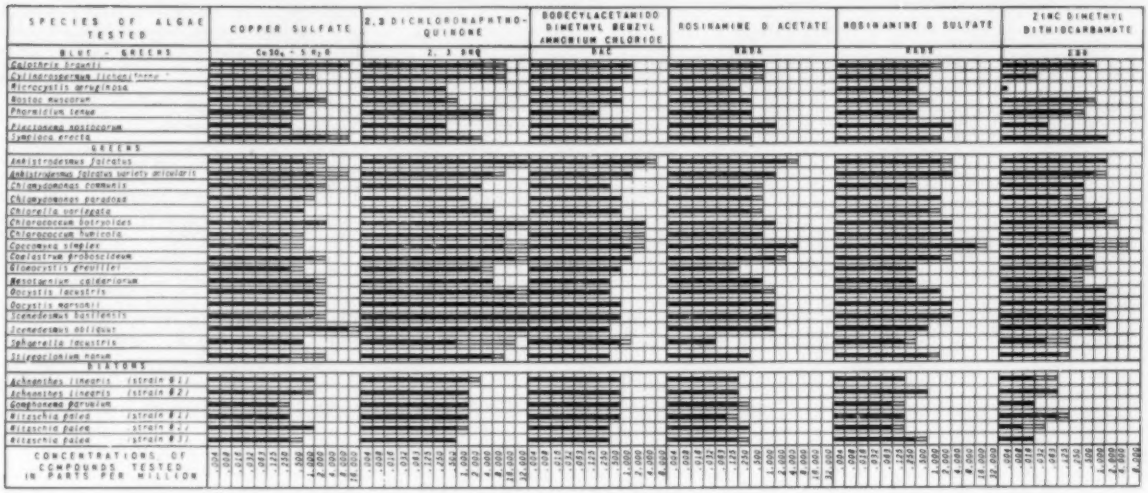


Fig. 1—TOXICITY of six chemical compounds to 30 cultures of algae. Solid bars indicate normal algal growth; open bars, partial algal growth.

particularly significant because copper sulfate has been considered to be a general algicide for many years.

At 1 ppm, copper sulfate controlled the growth of *Coccomyxa simplex*, a species which was one of the most resistant to the other chemicals. Copper sulfate also displayed a somewhat selective toxicity to the diatoms at a concentration of 2 ppm. At this concentration it controlled 100 percent of the diatoms, while it was toxic to only 35 percent of the green and 57 percent of the blue-green algae.

The compound 2, 3-dichloronaphthoquinone (2, 3-DNQ) was clearly the most selective in controlling the growth of certain of the blue-green algae. At 0.5 ppm it controlled 28 percent of the blue-green algae under test without being toxic to any of the diatoms and green algae. It inhibited the growth of *Microcystis aeruginosa* and *Plectonema nostocorum* at a concentration of 0.5 ppm. Fitzgerald *et al.* reported this compound as being selectively toxic to *Microcystis aeruginosa* at a concentration of 2 μg. per liter (0.002 ppm)[6]. They also pointed out that in alkaline solutions 2, 3-dichloronaphthoquinone hydrolyzes to 2-chloro-3-hydroxynaphthoquinone and that this latter compound is less toxic to *Microcystis aeruginosa* than the former.

This, perhaps, is the explanation for the differences in results, since the culture medium used in the present work had a pH of over 8.0. At higher concentrations (2 ppm) 2, 3-DNQ could also be considered to be selectively toxic to the diatoms. It was toxic to 83 percent of the diatoms under test at this concentration while being toxic to only 6 percent of the green and 43 percent of the blue-green algae tested.

Dodecylacetamido dimethyl benzyl ammonium chloride (DAC) displayed general algicidal properties at a concentration of 2 ppm. At this strength it was capable of preventing growth of all the diatoms and blue-green algae and 76 percent of the green algae. At a concentration of 1.0 ppm, it was to some degree selective for the diatoms, since all of these organisms were controlled while only 57 percent of the blue-green and 59 percent of the green algae were controlled.

DAC was the only one of the six compounds tested which was toxic to a larger percentage of the green algae than to the blue-green algae, and this was true only at a low concentration, 0.5 ppm. At a concentration of 0.5

Relative Effectiveness of the Six Compounds

Figure 1 indicates the selective algicidal properties of the six compounds tested. Table 3 indicates the relative general algicidal properties of these compounds by ranking the six compounds in the order of their toxicity for each species of alga. From this latter table it is evident that zinc dimethyl dithiocarbamate (ZDD) was the most effective of the six compounds as a general algicide. Rosin amine D acetate was slightly less toxic than ZDD to the entire group of algae tested. These two compounds were followed in order of decreasing toxicity by dodecylacetamido dimethyl benzyl ammonium chloride (DAC), rosin amine D sulfate (RADS), copper sulfate ($CuSO_4.5H_2O$), and 2, 3-dichloronaphthoquinone (2,3-DNQ).

If the toxicity of the six compounds to the seven species of blue-green algae is considered alone, it will be noted that there is little difference between the algicidal properties of ZDD and RADA, which were the most toxic to this group. DAC and RADS were also somewhat alike in their toxicity to this group of algae, although less toxic than the two aforementioned compounds.

It is also evident from Table 3 that DAC was slightly more effective against the seventeen species of green algae than was RADA. Also, 2,3-DNQ was the least effective of the six compounds tested against the green algae. The total of its assigned numbers for this group of algae was 100 out of a possible 102 (Table 3).

This again indicates the selective toxicity of this compound to certain species of blue-green algae. As previously pointed out, it was able to control the growth of some of the species of blue-green algae at 0.5 ppm, while it required at least 2.0 ppm to control the growth of any of the seventeen species of green algae, and 1.0 ppm to prevent the growth of any of the six diatoms tested (Fig. 1).

ZDD was the most effective of the compounds in controlling the growth of the diatoms tested. RADA and RADS showed little difference in their general toxicity to this group of algae.

Fish Toxicity

Of the six compounds tested, ZDD was the most toxic to fishes (Table 4). The 96-hour TL_m-value (that concentration at which 50 per cent of the test fish survived) for this compound was 0.008 ppm. The TL_m-

TABLE 3

Six Chemical Compounds Ranked in Order of Toxicity For Each Species of Algae

Species of Algae	Order of Toxicity for Each Species					
	$CuSO_4 \cdot 5H_2O$	2, 3-DNQ	DAC	RADA	RADS	ZDD
Blue-Green Algae:						
Calothrix braunii	5.5	5.5	3.5	1.5	3.5	1.5
Cylindrospermum licheniforme	4.5	6.0	4.5	2.5	2.5	1.0
Microcystis aeruginosa	4.0	4.0	6.0	2.0	4.0	1.0
Nostoc muscorum	6.0	3.5	3.5	1.0	3.5	3.5
Phormidium tenue	5.0	6.0	1.0	3.0	3.0	3.0
Plectonema nostocorum	2.5	2.5	4.5	4.5	6.0	1.0
Symploca erecta	6.0	5.0	2.0	1.0	3.5	3.5
Total	33.5	32.5	25.0	15.5	26.0	14.5
Green Algae:						
Ankistrodesmus falcatus	2.5	6.0	4.5	4.5	2.5	1.0
Ankistrodesmus falcatus [a]	5.5	5.5	2.0	2.0	4.0	2.0
Chlamydomonas communis	5.5	5.5	2.0	4.0	2.0	2.0
Chlamydomonas paradoxa	5.0	5.0	2.5	2.5	5.0	1.0
Chlorella variegata	2.0	6.0	2.0	2.0	4.5	4.5
Chlorococcum botryoides	3.5	6.0	3.5	1.0	3.5	3.5
Chlorococcum humicola	2.5	6.0	4.5	2.5	4.5	1.0
Coccomyxa simplex	1.0	6.0	2.0	3.5	5.0	3.5
Coelastrum proboscideum	4.0	6.0	2.0	4.0	4.0	1.0
Gloeocystis gravillei	4.0	6.0	4.0	1.0	2.0	4.0
Mesotaenium caldariorum	5.0	6.0	2.0	4.0	2.0	2.0
Oocystis lacustris	5.0	6.0	1.0	3.0	3.0	3.0
Oocystis marsonii	4.5	6.0	1.0	2.5	4.5	2.5
Scenedesmus basiliensis	4.5	6.0	1.0	2.5	4.5	2.5
Scenedesmus obliquus	5.0	6.0	1.0	3.5	2.0	3.5
Sphaerella lacustris	4.0	6.0	5.0	1.0	3.0	2.0
Stigeoclonium nanum	5.0	6.0	2.5	2.5	4.0	1.0
Total	68.5	100.0	42.5	46.0	60.0	40.0
Diatoms:						
Achnanthes linearis (Strain 1)	5.0	6.0	4.0	2.5	2.5	1.0
Achnanthes linearis (Strain 2)	5.5	5.5	3.5	2.0	3.5	1.0
Gomphonema parvulum	3.5	6.0	5.0	3.5	2.0	1.0
Nitzschia palea (Strain 1)	4.0	6.0	5.0	2.0	2.0	2.0
Nitzschia palea (Strain 2)	5.5	5.5	3.5	3.5	2.0	1.0
Nitzschia palea (Strain 3)	5.0	5.0	2.5	2.5	5.0	1.0
Total	28.5	34.0	23.5	16.0	17.0	7.0
Grand Total	130.5	166.5	91.0	77.5	103.0	61.5

[a] Variety acicularis.

values for $CuSO_4.5H_2O$ showed little variance for 24, 48, and 96 hours. At 24 and 48 hours the TL_m-value for this compound was 0.19 ppm and for 96 hours, 0.18 ppm.

The 24-hour TL_m-value for RADS was 0.33 ppm and that of RADA was 0.23 ppm. However, the 96-hour TL_m—value for RADA remained at 0.23 ppm, while that for RADS decreased to 0.16 ppm. The TL_m-value for 2,3-DNQ decreased from 0.24 ppm at 24 hours to 0.15 ppm at 96 hours. DAC was the least toxic to fish of the six compounds. Its 24-hour TL_m-value was 0.72 ppm, while it decreased to only 0.65 ppm at 48 and 96 hours.

Discussion

Although zinc dimethyl dithiocarbamate (ZDD) was extremely effective in controlling the growth of the algae, its toxicity to fish would limit its usefullness as an algicide except in closed systems, in areas where its toxicity to fish would be of no consequence, or in isolated cases as a selective algicide in low concentrations.

It appears that both docecylacetamido dimethyl benzyl ammonium chloride (DAC) and rosin amine D acetate (RADA) have strong possibilities for use as general algicides. DAC would seem to be exceptionally good because it is comparatively less toxic to fish. DAC was particularly effective against the green algae, which are commonly the most resistant to algicides.

Copper sulfate has been used extensively as an algicide for many years. In these tests, however, it was not as effective in its general algal toxicity as four of the other compounds tested. This could be due to the chemical nature of the culture medium employed in this work. It is well known that under conditions of high pH and alkalinity, copper sulfate precipitates or complexes into insoluble copper compounds and its toxic effects are lessened.

Rosin amine D sulfate (RADS) exhibited some selective toxicity to the diatoms. Although it is closely related to RADA in chemical composition, it appears that RADA has greater potential for use as an algicide.

The quinone derivative, 2,3-dichloronaphthoquinone (2,3-DNQ), did not give any indications of general algicidal toxicity. However, it would certainly have value as a selective algicide for certain species of blue-green algae.

Summary

Six chemical compounds, copper sulfate, 2,3-dichloronaphthoquinone, dodecylacetamido dimethyl benzyl ammonium chloride, rosin amine D acetate, rosin amine D sulfate, and zinc dimethyl dithiocarbamate were tested for their toxicity to thirty species or strains of algae in culture. Each compound was tested in fourteen concentrations ranging from 0.004 to 32 ppm. Preliminary bioassay tests also were carried out with these six compounds to determine their toxicity to fish.

All six of the compounds exhibited some degree of selectivity to the various species of algae tested. In considering both algal and fish toxicity, dodecylacetamido dimethyl benzyl ammonium chloride, and rosin amine D acetate appear to have the best potentialities as general algicides. Zinc dimethyl dithiocarbamate was extremely good in controlling the growth of the algae, but was highly toxic to the test fish. Rosin amine D sulfate did not appear to be as effective as rosin amine D acetate and was more toxic to the test fish in 96 hours. The compound, 2,3-dichloronaphthoquinone, was confirmed as being selectively toxic to some of the blue-green algae. Copper sulfate appeared to be selective rather than general in its algicidal effects when used at concentrations of 2 ppm or less.

Acknowledgments

The authors are indebted to C. M. Tarzwell, Chief of Aquatic Biology, for his guidance and criticisms of this research and manuscript; to E. K. Harris, Analytical Statistician, for his aid and guidance in the statistical evaluation of some of the research; and to Croswell Henderson, Aquatic Biologist, for his guidance in carrying out the fish toxicity tests. All are on

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TABLE 4

Fish Toxicity of Six Chemical Compounds

Compounds Tested	TLm—Values, ppm.			Initial Chemical Condition of Experimental Water			
	24 Hr.	48 Hr.	96 Hr.	D.O., ppm.	pH	Total Alk., ppm.	Hardness[d] ppm.
Copper sulfate ($CuSo_4.5H_2O$)	0.19	0.19	0.18	7.5	7.5	34	41
2,3-dichloronaphthoquinone	0.24	0.22	0.15	8.0	7.2	36	38
Dodecylacetamido dimethyl benzyl ammonium chloride	0.72	0.65	0.65	7.8	7.6	34	30
Rosin amine D acetate	0.23	0.23	0.23	8.0	7.7	34	37
Rosin amine D sulfate	0.33	0.18	0.16	7.5	7.4	20	23
Zinc dimethyl dithiocarbamate	0.02	0.01	0.008	7.0	7.5	34	32

[a] Test animal: fathead minnow (**Pimephales promelas**).
[d] **Versenate hardness.**

Weehawken Sewer Authority To Build Treatment Plant

McClave and McClave to Prepare $1,500,000 Design

Preparation of plans and specifications for a proposed $1,500,000 sewage treatment plant to be built by the Weehawken (N.J.) Sewer Authority will be begun immediately under the appointment of the consulting engineering firm of McClave and McClave, Cliffside Park, N. J. The firm was selected by the authority at a recent meeting.

Weehawken is under orders from the Interstate Sanitation Commission to cease pollution of the Hudson River. The new plant is being planned with that objective in mind.

Fluid Controls Institute Adopts Standard Terms

The Fluid Controls Institute, formerly the National Steam Specialty Club, an organization including manufacturers of control valves, regulators, solenoid valves, controllers and other auxiliary control equipment, has announced adoption of a standard classification and terminology system for power actuated valves.

The project was undertaken by the Institute to provide a practical framework of standard terms for everyday use by operating engineers, instrument engineers and mechanics. It is expected to clear up existing semantic ambiguities and uncertainties, and at the same time provide a broad base for new and accepted names and terms which should be recognized and preserved.

Results of the project are published in a 12-page booklet entitled, "Standard Classification and Terminology for Power Actuated Valves," which is available from Fluid Controls Institute, Box 191, Decatur, Ill.

City Employees of Cairo Must Keep Awake on The Job

One of the rules and regulations for the employees on the pay rolls of the City of Cairo is the following:

"MUNICIPAL EMPLOYEES caught sleeping during office hours will forfeit 5 days pay; those reading newspapers, 15 days pay"—*City of Cairo, Egypt.*

Here is another:

"During office hours government workers must stop opium smoking."
—*Iranian Authorities.*

"The one best investment is in the tools of one's own profession or trade."
—*Ben Franklin*

First International Ozone Conference

Sponsored by Armour Research Foundation

The first International Ozone Conference is to be held in Chicago at Hotel Sheraton on Nov. 28, 29, 30, 1956 under the sponsorship of the Armour Research Foundation of the Illinois Institute of Technology. Scientists from various parts of the world are participating in the technical program which covers a wide variety of papers on ozone, its reactions, applications in industry as well as water and sewage treatment.

In water and sewage treatment papers are being presented Nov. 28th on the following topics:

"Experiences With Drinking Water Ozonation"—*Toricelli.*

"Disinfection of Sewage With Ozone"—*Various*

"Comparison of Bacterial Reductions by Chlorine & Ozone"—*FeHuer & Ingols*

"Ozone Production and Costs at Philadelphia"—*Bean*

"Operation of the Paris Water Ozonation Plant"—*Guinvarch*

"Determination of Residual Ozone in Solution"—*Ingols*

In addition to Armour Research Foundation a number of companies interested in Ozone are co-sponsoring the first International Ozone Conference. Amongst these are Westinghouse, Du Pont, Welsbach and National Science Foundation.

South Dakota Water and Sewage Works Conference*

Holds 22nd Annual Meeting in Aberdeen

OFFICERS AND DIRECTORS

Left to Right:
Charles E. Carl, (Sec'y.-Treas.), Pierre;
Francis McNeary, (Director), Aberdeen;
Leonard Haddorff, (Pres.), Wessington Springs;
Charles Clark, (Past-Pres.), Mitchell;
Roy Heiens, (Vice-Pres.), Philip;
William Mailloux, (Director), Sturgis;
Wallace Johnson, (Director), Huron;
Harold Tormey, (Director), Mitchell.

The water and sewage works operators of South Dakota opened their 22nd Annual Conference at Aberdeen, South Dakota, September 19, 1956 with a smoker and dutch lunch as a courtesy of the host city. There was a total of 120 registrations. Although Aberdeen is not centrally located, the entire state was well represented. Those registering came from 24 cities in South Dakota and 11 out-of-state communities.

The first general session was devoted to topics of interest to both water and sewage works operators. After a welcoming address by Mayor J. Clifton Hurlbert and the response by Conference President Charles Clark, Paul Bolton, from Region VI of the U. S. Public Health Service, discussed the new Federal Water Pollution Control Act, Public Law 660. Those in attendance were extremely interested in this act and many questions were presented to Mr. Bolton. City Commissioner Francis McNeary then discussed the Aberdeen sewer explosions; he stressed mainly the injuries and deaths resulting from explosive materials in sanitary sewers, the survey procedures to pin-point the cause, and corrective action. Mr. Joe Grimes, Chief Engineer and Executive Officer of the South Dakota Water Resources Commission, then discussed the activities of this commission, with particular respect to city water rights and their obligations.

The following papers were presented at separate sections during the Thursday afternoon session:

Water Section

"Ground Water Geology"—J. R. Jones, District Geologist, United States Geological Survey, Huron

"Approval Program for Public Water Supplies"—Panel Discussion

Operators Discussion Period

Sewage Section

"Cooperative Industrial Waste & Municipal Sewage Treatment—Panel Discussion

"High-Rate Sewage Treatment Processes"—Leland Bradney, Supt., Sewage Treatment, Sioux Falls and Glen Wicklund, Dorr-Oliver, Inc., St. Paul

Operators' Discussion Period

The Annual Banquet was held in the Sherman Hotel at Aberdeen. Several awards were made at the banquet including: (1) the $50 cash award presented to Arley Campbell, Chamberlain Waterworks Operator, by Paul Tveite of the Flox Company, and (2) the Izaak Walton Plaque presented to Charles R. Price, Rapid City Sewage Treatment Plant Operator, by Calvin Cran of the South Dakota Division of the Izaak Walton League of America, Inc.

A general session was held Friday morning at the Sherman Hotel. Those in attendance had the opportunity to view an interesting film entitled "Water, Wealth or Worry for America". Following the film showing there were inspection trips to the Municipal Water Treatment Plant, Municipal Sewage Treatment Plant, and the Municipal Swimming Pool of Aberdeen.

Officers 1956-1957

The meeting concluded with the business luncheon on Friday noon, when the following officers were elected for the forthcoming year: President, Leonard Haddorff, Wessington Springs; Vice President, Roy Heiens, Philip; Directors: Edward Gaisbauer, St. Paul; Wm. Mailloux, Sturgis; Lyle Meadows, Watertown; Francis McNeary, Aberdeen; Wallace Johnson, Huron; and Harold Tormey, Mitchell; Charles E. Carl, Secy.-Treas., Pierre.

The use of chlorinated copperas to treat water at Akron, Ohio has resulted in a saving of $162,800 in 20 years.

* * *

Alfred Chalk, inspector of flushing for London County Council, gets the British Empire Medal (civil division). According to the official announcement, Mr. Chalk has "outstanding knowledge" of London's sewers.

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* A report by Charles E. Carl, Secy.-Treas. of the Conference

Concentric Orifice Diameters

Method of determining for fluid flow measurement

by ALEXANDER GOLDSTEIN

Mr. Goldstein is Senior Mechanical Engineer, West-Southwest Sewage Treatment Works, Metropolitan Sanitary District of Greater Chicago. This article was prepared by Mr. Goldstein as a convenient reference for the design of concentric orifices for metering fluid flow.

THE USE of a sharp-edge, concentric orifice as a primary element in a pipe line is a practical, inexpensive, and accurate means for measuring rate of fluid flow. A concentric orifice produces a geometrically uniform change in the cross-sectional area of a flowing stream. The resulting change in the static pressure across the orifice, from which the flow can be determined, is definitive for any particular orifice and rate of flow.

This discussion is limited to methods for determining orifice diameters for vena contracta taps and pertains to incompressible flow. These methods apply to liquids and gases which undergo a pressure drop across the orifice, with that pressure drop being a small percentage of the total gas pressure. It is desirable to keep the pressure drop less than five per cent of the total pressure of the fluid. Correction for Reynolds numbers above 15,000 and for expansion are considered.

Conditions

The accepted orifice standards, indicated in Fig. 1, must be adhered to. There must be a minimum of ten to twenty diameters of straight pipe upstream of the orifice and five downstream. The pipe must be smooth and free from encrustation and tubercles. The length of the cylindrical part of the orifice should not exceed one-eighth of the orifice diameter, one-thirtieth of the pipe diameter, or one-eighth of the difference of the two diameters, and should be the smallest of these. The remainder of the orifice plate thickness should be bevelled forty-five degrees downstream.

The upstream tap should be one-half to one pipe diameter from the face of the orifice plate. The downstream tap should be **N** diameters from the plate in the region of minimum static pressure. This location depends upon the ratio of orifice to pipe diameters, as is shown on the rectangular coordinate curves of Fig. 1. The diameter of the pipe taps should not exceed one-eighth of the pipe diameter and at no time be over one-half inch. The tap bore should be a minimum of two diameters in length, should enter the pipe with machine-like finish, and be free from burrs and metal cuttings.

Symbols

The following symbols are used:

A	=	Area of the orifice in square feet
β	=	Ratio d/D, orifice diameter to pipe diameter
C	=	Orifice coefficient not including the velocity of approach factor
cp	=	Viscosity of the flowing fluid in centipoises
cs	=	Viscosity of the flowing fluid in centistokes
d	=	Orifice diameter in inches
D	=	Pipe diameter in inches
g	=	Acceleration of gravity in feet per second per second = 32.16
G	=	gallons per minute
h	=	Orifice differential in inches of water column
H	=	Orifice differential in feet of flowing fluid column
M	=	Pounds per minute
Δp	=	Orifice differential in pounds per square inch = h/27.7
p	=	Upstream static fluid pressure in pounds per square inch absolute
T	=	Absolute temperature = degrees Fahrenheit plus 460
q	=	Cubic feet per second
Q	=	Cubic feet per minute
R	=	Reynolds number
ρ	=	Density in pounds per cubic foot
v	=	Specific volume in cubic feet per pound
Y	=	Expansion factor
$1/\sqrt{1-\beta^4}$	=	Velocity of approach factor
psig	=	Pounds per square inch gage pressure
psia	=	Pounds per square inch absolute pressure

Basic Equations

The basic orifice flow equation is:

$$q = CA\sqrt{\frac{2gH}{1-\beta^4}} \qquad (1)$$

In order to use a time interval of one minute and water column differentials, Eq. (1) is converted into the following forms:

$$Q = 1096.4\ CA\sqrt{\frac{h/\rho}{1-\beta^4}} \qquad (2a)$$

$$G = 8201\ CA\sqrt{\frac{h/p}{1-\beta^4}} \qquad (2b)$$

$$M = 1096.4\ CA\sqrt{\frac{h/\rho}{1-\beta^4}} \qquad (2c)$$

Introducing in Eq. (2) the orifice diameter, and giving **C** a value of 0.61

$$Q = 3.65\ d^2\sqrt{\frac{h/\rho}{1-\beta^4}} \qquad (3a)$$

$$G = 27.29\ d^2\sqrt{\frac{h/\rho}{1-\beta^4}} \qquad (3b)$$

$$M = 3.65\ d^2\sqrt{\frac{h/\rho}{1-\beta^4}} \qquad (3c)$$

Determination of d

When determining the value of **d**, the value of all other quantities either are known or assumed in any practical problem. The quantity of fluid flowing is calculated or estimated; the density is known from the temperature and pressure conditions of the fluids; the orifice differential is selected to suit manufactured meters or flowing conditions; the pipe diameter is obtained from computations made previously to the appearance of the metering problem. The only unknown is

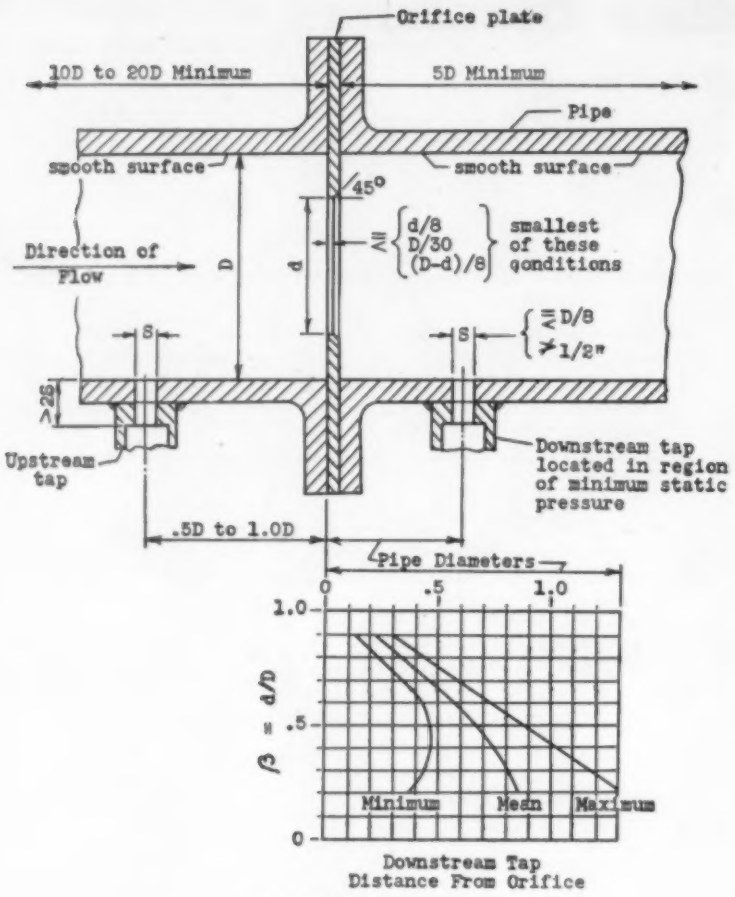


Fig. 1. ORIFICE tolerances

assumed to be the orifice diameter **d**. Any value of **d** that gives the correct value of **Q**, **G**, or **M** when substituted in any Eq. (3 a,b,c), is the correct solution, no matter how **d** is found.

One method employed by engineers to determine **d**, utilizes any of Eq. 3. By replacing **d** in Eq. (3a) with β**D**, this equation becomes:

$$\frac{Q}{D^2}\sqrt{\frac{\rho}{h}} = 3.65\sqrt{\frac{\beta^4}{1-\beta^4}} \qquad (4)$$

$$\text{or } K = \frac{Q}{D^2}\sqrt{\frac{\rho}{h}} = f(\beta) \qquad (5)$$

$$\text{and } f(\beta) = 3.65\sqrt{\frac{\beta^4}{1-\beta^4}} \qquad (6)$$

A graph, Fig. 2, is drawn using values of $f(\beta)$ as ordinates and β as abscissas. The value of **K** is found from known or assumed values of **Q**, **D**, ρ, and **h**. Since $K = f(\beta)$, an ordinate point is established on the graph and from a corresponding abscissa point, β becomes known. Then, $d = \beta D$. Substituting the value of **d** in Eq. (3a) provides an adequate check.

Simplified Procedure

Although the above method for determining the orifice diameter is valuable, it suffers from a lack of straightforwardness. It does simplify the arithmetic somewhat, but uses several steps to complete the solution. These steps include computation, graph reference and further computation.

There is merit in devising a single formula, and carrying out directly arithmetic computations to obtain the answer. Algebraic solutions of Eq. (3a, b, c) in which values for the known and assumed quantities are entered and **d** directly computed, can readily be devised. To accomplish this end, Eq. (3a, b, c) are solved for **d** resulting in the following forms:

$$d = \frac{\sqrt{Q}}{\left[13.3\,\frac{h}{\rho} + \frac{Q^2}{D^4}\right]^{1/4}} \qquad (7a)$$

$$d = \frac{\sqrt{G}}{\left[745\,\frac{h}{\rho} + \frac{G^2}{D^4}\right]^{1/4}} \qquad (7b)$$

$$d = \frac{\sqrt{M}}{\left[13.3\,h\rho + \frac{M^2}{D^4}\right]^{1/4}} \qquad (7c)$$

Using these equations, the determination of orifice diameters is a direct procedure which involves the introduction of numerical values of **Q**, **G** or **M**, and **h**, **P** and **D** into the appropriate formula, followed by arithmetic solution for **d**. The computed values of **d** are checked with the proper equation of group (3).

The preceding method is satisfactory for ordinary needs. The orifice diameter will have been accurately determined by the use of any of the equations in group (7). For normal quantities of flow in a particular size of pipe, **d** can be used in orifice formulas without any further refinement.

Figure 2 contains a second curve showing the unrecoverable loss due to metering in percent of differential head. This is of particular significance for gases of low total static pressure where the head available for metering is very limited.

Reynolds Number & Expansion Factor

If conditions require a solution for **d** with consideration of the Reynolds number and the expansion factor, it can now be done. The Reynolds number enters into the problem because the orifice coefficient of discharge, not including the velocity of approach factor, is not strictly constant, but varies as a function of the Reynolds number. The values of **d** obtained from the equations of group (7) will be changed very little even after correction and, therefore, **d** can be used in the following equations to obtain the Reynolds numbers.

$$R = \frac{23{,}700\ Q}{d\ cs} \qquad (8a)$$

$$R = \frac{3{,}170\ G}{d\ cs} \qquad (8b)$$

$$R = \frac{380\ M}{d\ cp} \qquad (8c)$$

The viscosities of water, air and steam can be obtained from Fig 3,

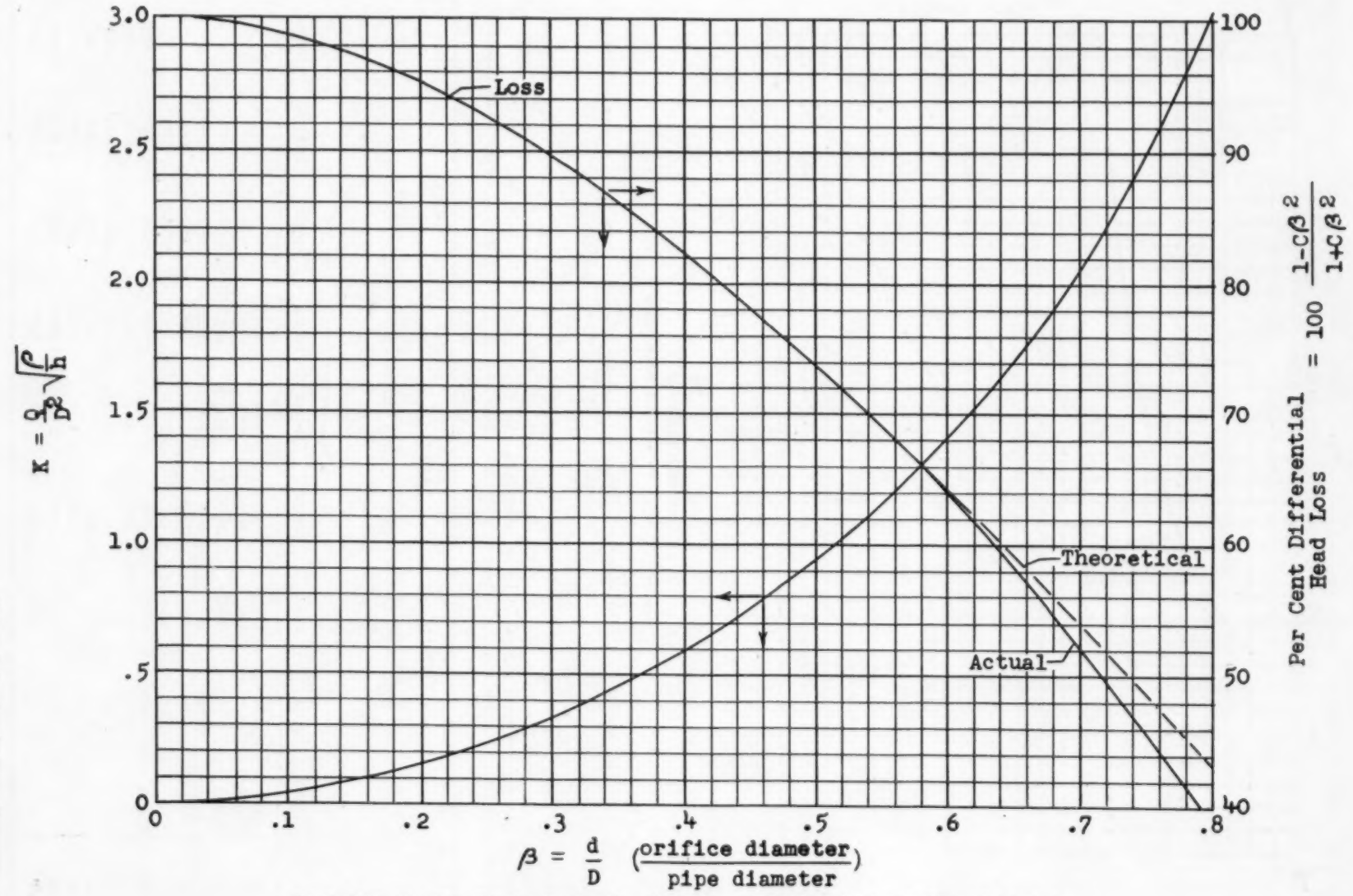


Fig. 2. Ratio of orifice diameter to pipe diameter vs K as a function of (β) and differential head loss

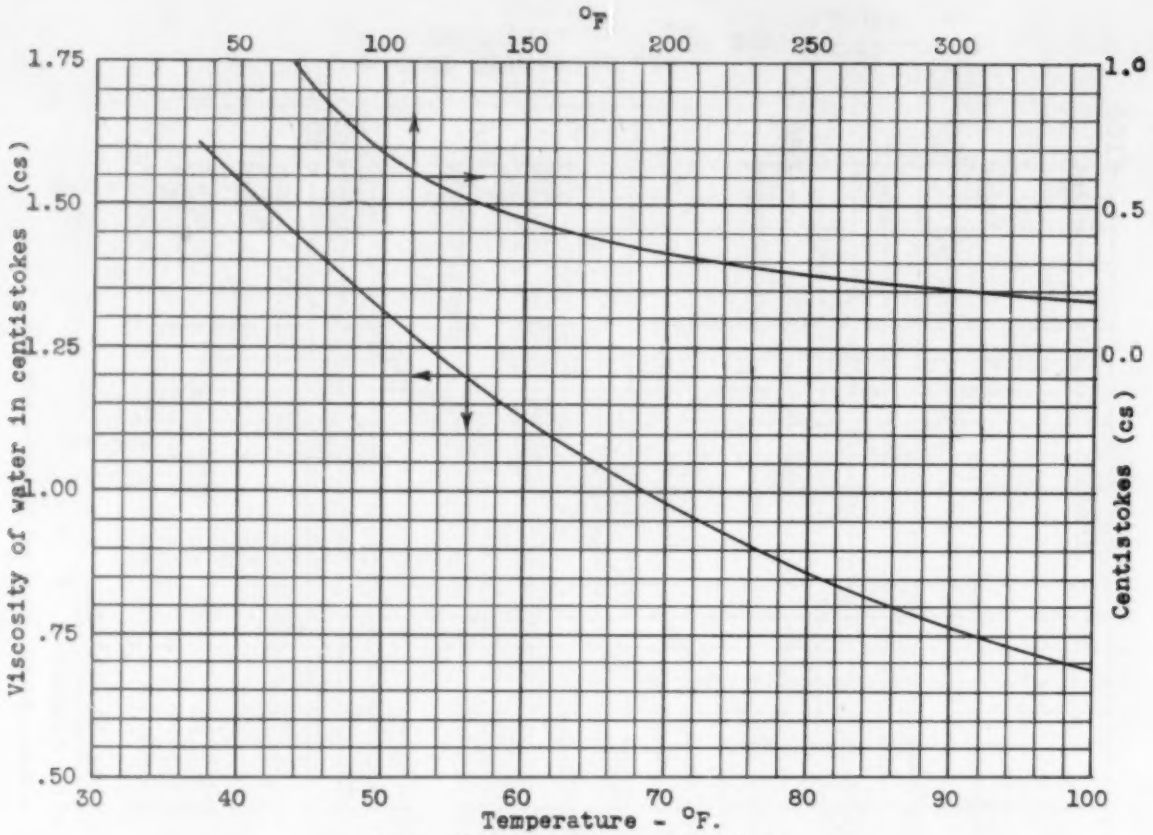


Fig. 3. VISCOSITY of water vs temperature

4 and 5 respectively. Table 1 contains the values of the orifice discharge coefficient **C** for corresponding Reynolds numbers and orifice to pipe diameter ratio **B**.

Because gases do expand somewhat even for the small reduction in pressure across a metering orifice, the expansion factor **Y** enters into the problem. Values for **Y** can be obtained from Fig. 6, in which **Y** ordinates are plotted against **h/27.7p** abscissas, the change in pressure over the total pressure. For any flow, Q_2, other than the maximum,

$$h_2 = h(Q_2/Q)^2 \qquad (9)$$

This h_2 is the orifice differential head used to obtain **Y** for average flow conditions.

If the value of **C** from Table 1 is

TABLE 1

Coefficient of Discharge C — For Various Reynolds Numbers

Not Including Velocity of Approach Factor

	Reynolds Numbers								
β	15,000	25,000	50,000	100,000	250,000	500,000	750,000	1,000,000	2,000,000
.20	.6042	.6006	.5982	.5964	.5944				
.25	.6048	.6017	.5991	.5972	.5953				
.30	.6060	.6030	.6003	.5985	.5965	.5953	.5950	.5948	
.35	.6078	.6050	.6021	.6000	.5985	.5974	.5972	.5970	
.40	.6105	.6071	.6042	.6020	.6004	.5995	.5992	.5990	
.45		.6097	.6064	.6042	.6027	.6017	.6013	.6010	
.50		.6122	.6088	.6065	.6052	.6040	.6036	.6032	.6025
.55		.6150	.6115	.6090	.6075	.6060	.6057	.6054	.6046
.60		.6178	.6142	.6117	.6095	.6080	.6076	.6073	.6064
.65			.6167	.6145	.6113	.6094	.6089	.6084	.6075
.70			.6187	.6170	.6125	.6100	.6091	.6083	.6070
.75			.6203	.6190	.6126	.6096	.6085	.6075	.6050
.80			.6210	.6197	.6116	.6080	.6067	.6054	.6025

significantly different from the **C** value used in equations of group (7), (i.e., 0.61) and/or the expansion factor **Y** is not close to unity, then the orifice diameter **d** can be found to a more exact degree by the use of the appropriate equations following:

$$d = \frac{\sqrt{Q}}{\left[35.76\ Y^2C^2\frac{h}{\rho} + \frac{Q^2}{D^4}\right]^{1/4}} \quad (10a)$$

$$d = \frac{\sqrt{G}}{\left[2000\ Y^2C^2\frac{h}{\rho} + \frac{G^2}{D^4}\right]^{1/4}} \quad (10b)$$

$$d = \frac{\sqrt{M}}{\left[35.76\ Y^2C^2\ h\rho + \frac{M^2}{D^4}\right]^{1/4}} \quad (10c)$$

The oirfice diameter is determined for the normal maximum flow condition, but the values of **Y** and **C** used are for average flow conditions. This gives the best accuracy at usual operating conditions. A check is made by substituting the new values of **d** in the following appropriate basic equations of orifice flow, which include the expansion factor.

$$Q = 5.98\ YC\ d^2\sqrt{\frac{h/\rho}{1-\beta^4}} \quad (11a)$$

$$G = 44.75\ YC\ d^2\sqrt{\frac{h/\rho}{1-\beta^4}} \quad (11b)$$

$$M = 5.98\ YC\ d^2\sqrt{\frac{h\rho}{1-\beta^4}} \quad (11c)$$

Data Values

The density of water at ordinary temperature can be taken as 62.3 pounds per cubic foot without appreciable error. For higher temperatures, steam tables can be consulted. Likewise, the specifc volume for steam can be obtained from steam tables. The density of air is determined from the gas law relationship $\rho = 2.7\ p/T$. The density of standard air is 0.0749, taken at 68° F and 50 percent relative humidity and at a pressure of 29.92 inches of mercury.

Gas or Gas Mixtures

When the fluid is a gas or a mixture of gases, the pressure, temperature and composition must be known to measure its rate of flow. To obtain the density of a mixture of gases, use the equation

$$\rho = .0932\frac{p}{T}(r_1m_1 + r_2m_2 + \ldots r_nm_n) \quad (12)$$

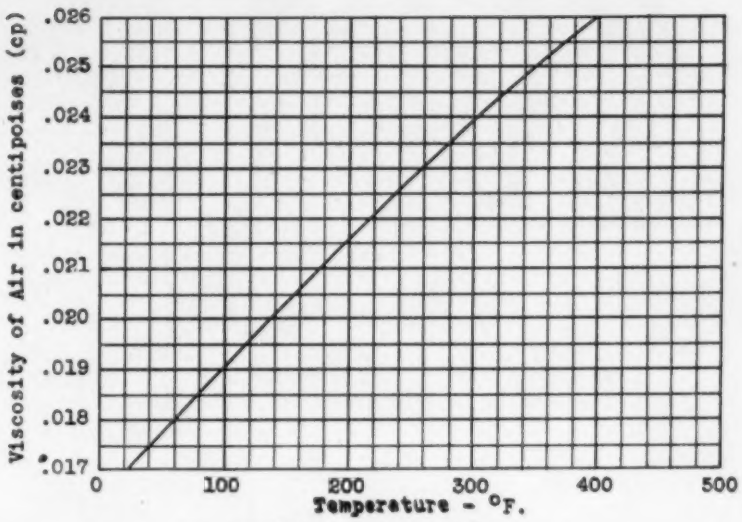


Fig. 4. VISCOSITY of air vs temperature

where r_1, r_2, r_n = percent of constituent gases by weight/100 and m_1, m_2, m_n = molecular weight of constituent gases.

Where it is desired to know the orifice differential for an existing metering orifice installation use the equations:

$$h = \frac{Q^2\ \rho\ (1-\beta^4)}{35.76\ Y^2C^2\ d^4} = \frac{Q^2\ \rho\ (1-\beta^4)}{13.3\ d^4},$$
for Y = 1 & C = 0.61 (13a)

$$h = \frac{G^2\ \rho\ (1-\beta^4)}{2000\ Y^2C^2d^4} = \frac{G^2\ \rho\ (1-\beta^4)}{745\ d^4},$$
for Y = 1 & C = 0.61 (13b)

$$h = \frac{M^2\ (1-\beta^4)}{35.76\rho Y^2C^2d^4} = \frac{M^2\ (1-\beta^4)}{13.3\ \rho\ d^4},$$
for Y = 1 & C = 0.61 (13c)

Loss of Head

The theoretical loss of head curve (Fig. 2) was obtained by plotting the ratios of (1) the loss of head due to imaginary sudden increase in pipe section from the area at the vena contracta to (2) the difference in velocity heads between that exisitng at the vena contracta and the full flowing pipe. It is seen that the theoretical and actual losses are identical up to a β value of 0.6 at which point they slightly diverge. This divergence is of little practical significance. The percent loss of head due to metering can be calculated from the equation:

$$\text{Percent Head Loss} = 100\frac{1-C\beta^2}{1+C\beta^2} \quad (14)$$

References

In compiling Table 1 and producing Fig. 6, information was obtained from the publication of the American Society of Mechanical Engineers on Fluid Meters. In order to provide for the variation in **C** for pipe size as well as Reynolds Number, average curves were plotted with **C** ordinates and β abscissas for various values of Reynolds numbers and sizes of pipe. For values of β below 0.25 and above 0.75, the true value of **C** for some conditions were somewhat off the average, but not significantly as far down as 0.20 or up to 0.80. Also, the graph of the expansion factor **Y** is an average for all values of β and gives a good degree of accuracy. For further refinement in the determination of orifice diameters, the above publication can be very helpful.

Example 1.

Find the orifice diameter for these flow conditions: 4800 cfm of free standard air at maximum flow; 3600 cfm at average flow; 12-in. internal diameter pipe; 8.5 psig pressure; 140°F temperature; 29.5 in. of mercury barometer, and 20 in. water column maximum orifice differential.

Under pipe conditions,

$p = 8.5 + (0.491 \times 29.5) = 23$ psi

$\rho = 2.7\ p/T = 2.7 \times 23/(140 + 460) = 0.1035$ lb/cu ft

For maximum flow,

$M = 4800 \times .0749 = 359.5$ lb min.

$Q = 359.5/.1035 = 3475$ cu ft/min.

Solution using equation (6) and Figure 2: From equation (6),

$$K = \frac{3475}{144}\sqrt{\frac{.1035}{20}} = 1.735$$

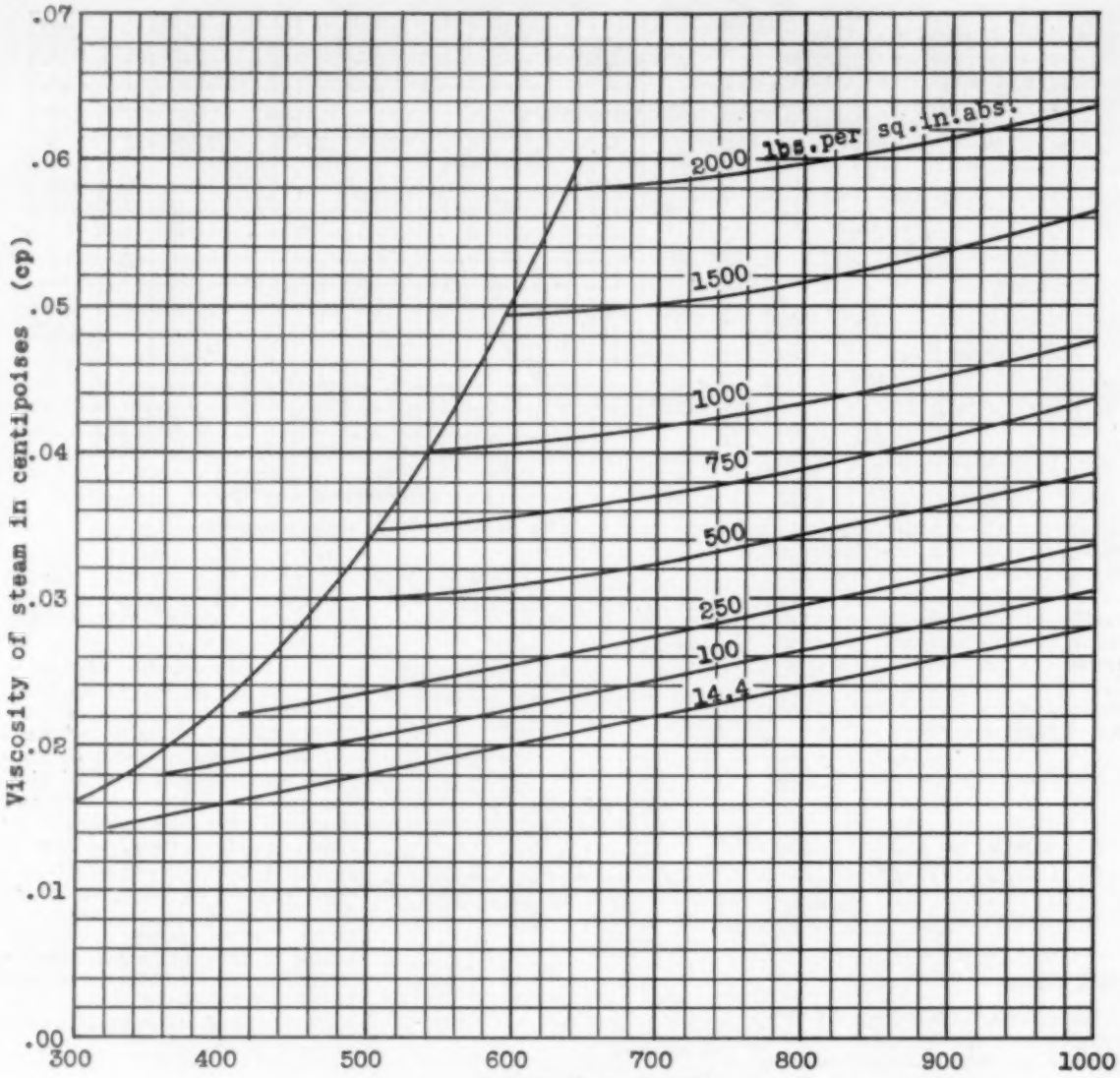


Fig. 5. VISCOSITY of steam vs temperature

From Fig. 2

$\beta = .655$

$d = \beta D = .655 \times 12 = 7.86$ in.

Check, using equation (3a):

$$Q = 3.65 \times 7.86^2 \sqrt{\frac{20/.1035}{1-.655^4}}$$

$= 3475$ cu ft/min

Solution using equation (7a):

$$d = \sqrt{3475}\left[(13.3 \times \frac{20}{.1035}) + \frac{3475^2}{12^4}\right]^{-1/4}$$

$= 7.86$ in.

$\beta = 7.86 \times 12 = .655$

Check, using equation (3a), is the same as shown above.

Correcting for Reynolds number and expansion factor: Obtaining cp from Fig. 4 and applying Eq. (8c),

$$R = \frac{380 \times 3600 \times .0749}{7.86 \times .02} = 650{,}000$$

From Table 1, $C = .609$ with $\beta = .655$

From Eq. (9),

$h_2 = 20(3600/4800)^2 = 11.2$ in.

From which,

$h/27.7p = 11.2/27.7 \times 23 = .018$

From Fig. 6, $Y = .993$

Solution using Eq. (10a):

$$d = \sqrt{3475}\ [(35.76 \times 0.993^2 \times 0.609^2 \times 20/0.1035) + 3475^2/12^4]^{-1/4}$$

$= 7.90$ in.

$\beta = 7.90/12 = .658$

Check, using Eq. (11a):

$$Q = 5.98 \times .993 \times .609 \times 7.90^2 \times \sqrt{\frac{20/.1035}{1-.658^4}} = 3475 \text{ cu. ft/ min}$$

Example 2.

Find the orifice diameter for these conditions: 900 gpm of water at maximum flow; 600 gpm at average flow; 8 in. pipe, (8.071-in. ID); 100 in. of water column differential at maximum flow; 70° F.

Solution using Eq. (7b):

$$d = \sqrt{900}\left[(745 \times \frac{100}{62.3}) + \frac{900^2}{8.071^4}\right]^{-1/4} = 4.918 \text{ in.}$$

$\beta = 4.918/8.071 = 0.609$

Check, using Eq. (3b):

$$G = 27.39 \times 4.918^2 \sqrt{\frac{100/62.3}{1-.609^4}}$$

$= 900$ gpm

Correcting for Reynolds number: From Fig. 3, at 68°F, cs = 1.01 and from Eq. (8b):

$$R = \frac{3170 \times 600}{4.918 \times 1.01} = 385{,}000$$

From Table 1, C = 0.6085

Using Eq. (10b):

$$d = \sqrt{900}\left[(2000 \times 1 \times .6085^2 \times \frac{100}{62.3}) + \frac{900^2}{8.014^4}\right]^{-1/4} = 4.92 \text{ in.}$$

$\beta = 4.92/8.071 = 0.61$

Check, using Eq. (11b):

$$G = 44.73 \times 1 \times .6055 \times 4.92^2 \sqrt{\frac{100/62.3}{1-.61^4}}$$

$= 900$ gpm

Example 3.

Find the orifice diameter for the following conditions: 48,000 lb per hr of steam at maximum flow; 40,000 lb per hr at average flow; 6-inch pipe (5.761-in. ID); 440 psia; 700°F; 140 in. water column differential.

From the steam tables, v = 1.494, and at 700° D = 5.79 in.

Solution using Eq. (7c):

$$d = \sqrt{\frac{48{,}000}{60}}\left[(13.3 \times 140/1.494) + \frac{800^2}{5.79^4}\right]^{-1/4} = 4.33 \text{ in.}$$

$\beta = 4.33/5.79 = .748$

Check, using Eq. (3c):

$$M = 3.65 \times 4.33^2 \sqrt{\frac{140/1.494}{1-.748^4}}$$

$= 800$ lb/min

Correcting for Reynolds number and expansion factor: From Fig. 5, cp = .033 and from Eq. (8c),

$$R = \frac{380 \times 800}{4.33 \times .033} = 2{,}130{,}000$$

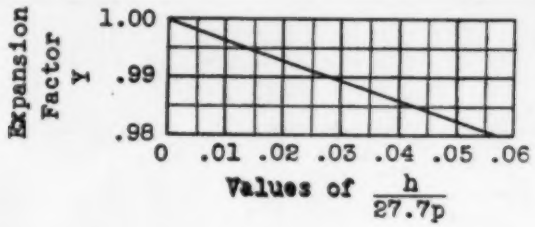


Fig. 6. EXPANSION factor vs ratio of orifice differential to static pressure

From Table 1, C = .605

From Eq. (9),

$$h = 140\left[\frac{40{,}000}{48{,}000}\right]^2 = 97.3$$

From which

$(h/27.7p = 97.3/(27.7 \times 440) = .008$

From Fig. 6, Y = .997

Solution using formula (10c):

$$d = \sqrt{800}\left[(35.76 \times .997^2 \times \frac{140}{1.494}) + \frac{800^2}{5.79^4}\right]^{-1/4} = 4.35$$

and $\beta = 4.35/5.79 = .75$

Check, using Eq. (11c):

$$M = 5.98 \times .997 \times .605 \times 4.35^2 \times \sqrt{\frac{140/1.494}{1-.75^4}} = 800$$

The actual orifice diameter must be corrected for the operating temperature, that is, made smaller so that it will increase to 4.35 inches when heated to 700°F.

Example 4.

Find the orifice diameter for the following conditions: 72,000 cfm at maximum flow, 55,000 cfm at average flow of a mixture of air and water vapor at 14.5 psia pressure, 300°F and 30 per cent by weight is the vapor in the gaseous mixture, 54 in. ID duct, and maximum orifice differential to be 4 in. of water column.

From Eq. (12),

$$\rho = .0932 \times \frac{14.5}{760}(.70 \times 29 + .30 \times 18)$$

$\rho = .04565$

Solution using Eq. (7a):

$$d = \sqrt{72{,}000}\left[(13.3 \times \frac{4}{.04565}) + \frac{72{,}000^2}{54^4}\right]^{-1/4}$$

$= 41.3$

$\beta = 41.3/54 = .765$

Check, using formula (3a):

$$Q = 3.65 \times 41.3^2 \sqrt{\frac{4/.04565}{1-.765^4}} = 72{,}000$$

Correcting for Reynolds number and expansion factor: From Fig. 3, viscosity of the air = 0.024 cp. From Fig. 5, viscosity of the steam = 0.014 cp. Assuming that the total viscosity of the mixture equals the weighted average, the viscosity of the mixture:

$$cp = .70 \times .024 + .30 \times .014 = .021$$

From Eq. (8c),

$$R = \frac{380 \times 55{,}000 \times .04565}{41.3 \times .021} = 1{,}100{,}000$$

From Table 1, C = .607

From Eq. (9),

$h_2 = 4\ (55{,}000/72{,}000)^2 = 2.33$

From which

$h/27.7p = 2.33/(27.7 \times 14.5) = 0.0058$

From Fig. 6, Y = .9975

Solution using Eq. (10a):

$$d = \sqrt{72{,}000}\left[(35.76 \times .9975^2 \times .607^2 \times 4/.04565) + \frac{72{,}000^2}{54^4}\right]^{-1/4} = 41.5$$

$\beta = 41.5/54 = .768$

Check, using Eq. (11a):

$$Q = 5.98 \times .9975 \times .607 \times 41.5^2 \times \sqrt{\frac{4/.04565}{1-.768^4}}$$

$= 72{,}000$

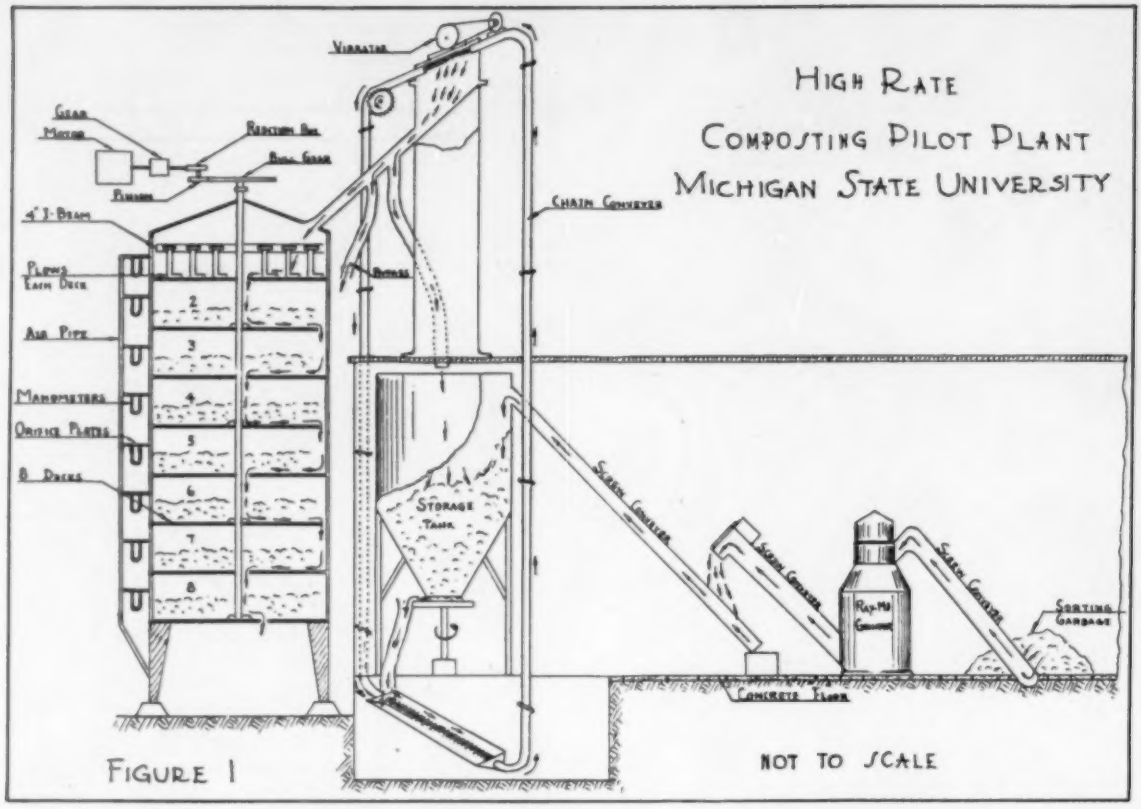


Fig. 1—DIAGRAM of composting pilot plant

Recent Developments In the Composting of Organic Wastes*

by ROBERT F. McCAULEY

Mr. McCauley is Associate Professor of Civil and Sanitary Engineering at Michigan State University, East Lansing, Mich. This article presents observations on experimental pilot plant studies of composting.

DURING the past few years discussions have begun to appear in the literature of Sanitary Engineering with regard to the treatment of organic wastes such as garbage and sewage sludge by composting. These discussions, together with a number of articles in popular magazines and in newspapers have raised the question as to whether this process is commercially feasible. Questions continue to arise as to whether this process can be carried out without odor or nuisance and whether the end product is of real economic value.

It has been pointed out by a number of writers on this topic that composting is not a new art. References to the Indore and Beccari processes which were developed around the turn of the century and a little later have been numerous. Further developments, typified by the Dano and other processes, have led to widespread use of composting for disposal of organic wastes in Denmark and other European areas. Yet, in spite of these local usages of composting in Europe and elsewhere those who are responsible for the treatment and disposal of garbage and similar wastes in this country are almost completely lacking in an understanding of the basic principles of the process.

*Presented before the Rocky Mountain Sewage and Industrial Waste Assn. Released for publication in *Water & Sewage Works.*

Questions About Composting

This apparent disinterest in a potentially useful process for waste treatment raises certain pertinent questions. These are:

1. Is composting an economically feasible method for disposing of garbage, refuse and sewage sludge?
2. If such a process is economically feasible does it have any serious disadvantages?
3. If composting is economically feasible and has desirable features, why is this process not more widely used for the treatment of wastes in the municipalities of the nation?
4. Can an actual profit be shown from the sale of compost so that the operation can be carried on at no cost to a municipality and with a real financial return above the operating cost?
5. Is machinery, equipment, and technical advice presently available to a municipality which desires to use this method for disposing of its waste materials?
6. Are secret bacteria and secret processes necessary to successful composting?

This list of questions is indeed a formidable array, yet each must be answered satisfactorily before consulting engineers and municipal officials can, with confidence, select composting as a means for disposing of refuse, sewage sludge, and other organic waste materials. It is the purpose of this paper to discuss these six questions in the light of present knowledge and in doing so to review the present status of what we like to term the science of composting.

That composting is not presently economically feasible for municipalities which must seek a proved method for disposing of garbage or refuse without odor or nuisance can hardly be disputed. No process, no matter how promising, can truly be described as completely feasible until it has been well tested on the proving ground of daily usage. The writer knows of no municipality in the nation which has successfully used composting as a method for disposing of its organic wastes. This statement is made in spite of the fact that the author is a member of the staff of Civil Engineering Department of Michigan State University which for two years, carried on extensive experimentation on the composting of garbage from the City of East Lansing, Michigan. Over this two year period, most of the garbage from East Lansing was composted, either by means of a continuous flow digester, or by windrow composting on a small field furnished by the university.

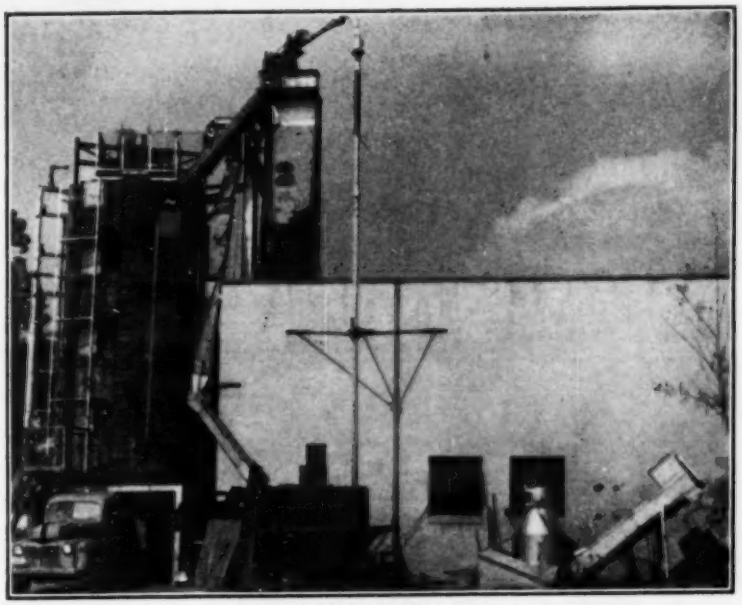


Fig. 2—EXPERIMENTAL digester

Michigan State Pilot Studies

In late June 1953, the construction of a modified Earp-Thomas type digester* was completed by the Michigan State University Civil Engineering Department. This unit was a five ton per day digester and was modeled after a number of digester prints which were supplied by Mr. G. H. Earp-Thomas and which represented the various digesters which had been considered or built by him over a period of 20 years. All prints were similar in that they were based upon a digester design which had been patented by Mr. Earp-Thomas. A line drawing of the plant as it now exists is shown in Fig. 1. A photograph of the digester appears in Fig. 2.

It is beyond the scope of this paper to discuss the digester operation other than in general terms. In summarizing this operation it may be stated that about one-half of the four tons per day of garbage from the City of East Lansing was composted in the unit over the two year period. Breakdowns were numerous and mechanical difficulties made operation difficult. Torques developed by the plows attached to the driving shaft were excessive. Probably the greatest difficulty faced was that of devising means for conveying the garbage after it was ground. This conveying problem was never completely solved for the raw ground garbage until the screw conveyor, shown in Fig. 1, was installed.

Digester Studies

Since the plant was experimental it cannot be stated that the operation was entirely satisfactory. While a large number of tons of garbage was composted, the digester was not without odor nuisances. A well composted material was not always produced, and at times the end product from the digester gave off a pungent odor. The digester was located a few hundred feet from a newly developed college housing area, which grew up during this two year period of operation; therefore, these odors caused numerous complaints and finally made it necessary to discontinue operation at the present site.

In early stages of operation, that portion of the garbage which could not be handled in the plant was buried. However, after about six months of operation a large 10-15 ton per hour Ray-Mo grinder† was installed in such a way as to permit excess garbage to be ground into a truck. This ground material was then hauled to a field and piled into windrows which were about six feet wide and three feet high.

Windrow Composting

During the summer of 1954, a series of experiments was conducted

*The Editor of *Water & Sewage Works* has suggested the term "humifier" as an alternate to "digester". The suggestion seems well taken; however the word "digester" has been used in previous Michigan State reports and will be used in this paper for that reason.

† Manufactured by Ray-Mo Mfg. Co., Verden, Neb.

with a Kemp soil shredder‡ to determine the feasibility of windrow composting this material. These tests indicated that if enough capacity were available for handling the material that such a process could be satisfactorily developed and that it would take seven to twelve days for fresh garbage to be composted into a reasonably satisfactory end product A photograph of a typical windrow pile is shown in Fig. 2.

Large scale windrow composting was begun about April 1, 1955 and continued for a period of about 40 working days. During that 40 day period, some 200 tons of raw or partly composted garbage was handled. The end product from the windrow process was reasonably satisfactory, but numerous complaints regarding the operation were finally instrumental in requiring that this work also be discontinued. Such complaints were primarily due to the fact that the windrow field was about 150 yards from a student housing area. The most serious cause of odors was the nature of the raw material which was being composted. This material had in many instances laid upon the ground for a period of two to ten months and in some cases the center portions had become extremely putrid. In addition, it cannot be denied that the large quantities of materials which were being handled at times gave off a pungent and even offensive odor. Machinery and man power for handling this 200 ton batch were very inadequate.

Conclusions Drawn From Field Studies

Thus, although several hundred tons of raw garbage were composted during the two year experimental period, it was finally necessary to shut down the operation due to odor difficulties. This experience appears to the author to answer both the first and second question raised; that is whether composting is an economic method for disposing of refuse, garbage, or sewage sludge, and what are its most important disadvantages? The answers appear to be that garbage was composted without excessive cost but that until the process is improved and that until completely satisfactory machinery and equipment are available, composting cannot be carried on with complete assurance that no odors will be produced. These remarks are particularly true for projects of limited financial support such as that described here.

‡ Manufactured by Kemp Mfg. Co., Erie, Penna.

Odor Problem

Experience during this two year period definitely points to the probability that further experimentation coupled with the development of more satisfactory equipment will probably lead to the formulation of an economic process which is relatively odor free. It cannot be said, however, on an honest basis that a process of composting has now been developed which is economic and completely free of odors and other nuisances. Such a statement in no way detracts from the advances in the art which were made during the Michigan State studies. Instead, these experiences show why future experiments and operations should be carried on at least a quarter mile from the nearest habitation and point out that future plants and equipment should be designed in the light of the work reported here and with adequate capacity and structural strength to handle all of the material which must be treated upon a routine basis.

It may also be said that, in general, difficulties in plant operations stemmed from mechanical failures and the inability of equipment to handle material in the necessary manner and at a high enough rate to provide for proper biological fnuctioning of the process. In other words, equipment failure, rather than biological difficulties prevented the full development of a commercial composting process.

The Fly Problem

A problem which attends all refuse disposal operations is that of fly nuisance. Fortunately, no breeding of flies can take place in properly turned windrow piles or in properly operated digesters because of high temperatures generated in the material. However, garbage trucks continually bring flies into the premises of such operations and vigorous measures are necessary to prevent the development of unhealthy conditions. Modern insecticides have proved completely adequate for this purpose, and it had been found possible to operate during the fly season for three summers without excessive fly nuisance.

Economic Advantage

The economic advantage of composting over a process such as the anaerobic digestion of sewage sludge was also shown by operation of this experimental plant. Composting is an aerobic process which can be made to take place quickly and which requires only a fraction of the space demanded for the digestion of a liquid material. Such advantages suggest that composting may materially reduce the cost of treating solid organic wastes. In addition, the end product is a useful material which is pleasant in appearance and in smell. It is an extremely effective soil conditioner and has a high capacity for holding moisture. Its odor is earthly and pleasant. High temperatures generated probably assure the destruction of pathogenic organisms since these temperatures are well above the pasteurization temperatures for milk and other liquid food.

Present and Future Status

It is now possible to turn to the third and fourth questions which were initially suggested. These questions are with regard to why the process is not more widely used and whether a profit can be shown in such operations. The answer to these questions is now quite apparent. The process is not more widely used because adequate techniques and equipment are not fully developed which can be sold with reliability upon a commercial basis and with absolute assurance that they will function in a manner which will be completely satisfactory to the using municipality. We may be upon the threshold of such development, but this has not yet taken place and until it does take place, the process will not be widely used for obvious reasons.

As to whether a profit over and above the operating expenses can be shown, the answer must be that experience will determine whether such profit can be derived. Present indications are that municipalities cannot expect to get rich by treating their garbage but that vaulable savings can be effected and that the process will probably be less costly than methods now popular in the waste treatment field. In addition, the use of composting digesters and similar equipment in large cities may be of material advantage in the continued battle against smog since in many instances waste incinerators have proved to be among the worst offenders in this respect.

As to the status of machinery and equipment as well as technical advice, little more may be added. The Michigan State experience has pretty well established that commercial grinding, dewatering, and conveying equipment is satisfactory in plant operation. The grinder previously mentioned has proved particularly valuable for the grinding of raw garbage and is quite adequate for this purpose. Screw conveyors have been shown to be a satisfactory means for conveying ground

garbage and it is probable that belt conveyors will also be adequate for this purpose. At least two soil shredders of the type now used by nurserymen for shredding peat and other soils have proved extremely useful for windrow composting. An automatic turning machine is now in the process of development by an Oklahoma concern. A Canadian concern has developed a prototype for a promising digester, but a full scale model has not yet been built. Other concerns and organizations are intensely interested in the processes involved and in the development of equipment, but none has yet been produced to this writer's knowledge which could be termed satisfactory for this purpose.

No Secret Bacteria

The final question which was raised was as to whether secret bacteria and processes are of value for composting organic wastes. The answer to this question is that so far as this writer knows, it has never been demonstrated that such bacteria or processes are of value. No secret bacteria or processes were utilized in the studies and experiments reported here except for testing whether or not such bacteria and processes are of value. No difference between results obtained with and without proprietary methods was observed. Such results were fully in accord with those that would be anticipated from the principles of microbiology since all of the necessary organisms required for composting are indigenous to both soil and garbage and it is necessary only to provide the necessary environmental conditions for these organisms to grow and multiply.

Principles of Composting

As previously mentioned, composting is essentially an aerobic process. In this process, waste organic materials are ground or shredded and then either piled in windrows or fed into the decks of a digester. In both the digester and windrow process, the basic biological principle is the same. Oxygen from the air penetrates into voids of the material where it dissolves in the liquid moisture films and is carried to aerobic bacterial organisms which are the active agents in breaking down the waste materials. It is extremely doubtful, however, that oxygen can be carried into the mass of composting material at such a rate as to maintain a completely aerobic population, and it seems more probable that the process is actually a combination of anaerobic and aerobic digestion with aerobic organisms predominating in the outer portions of the individual particles of material and anaerobic organisms dominating in the central portions which receive a negligible supply of oxygen. Since aerobic organisms are in general more efficient for these purposes than anaerobic organisms, aerobic breakdown is doubtless largely responsible for the biological changes.

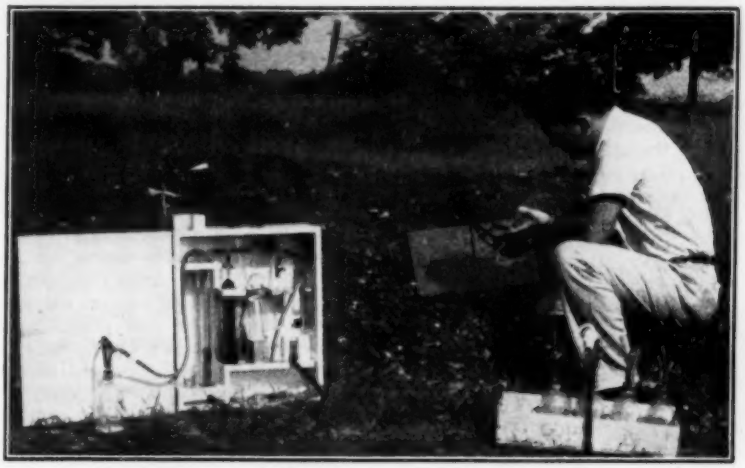


Fig. 3—GAS analysis in windrow pile

Voids and Oxygen Necessary

Numerous field experiences have demonstrated that solid organic materials are poorly broken down in a predominantly anaerobic process and that an adequate oxygen supply is essential to successful composting. For this reason, it is necessary that some provision be made in both digester and windrow processes for a continuous supply of oxygen to the composting mass. In digester operation, oxygen is supplied by a turning mechanism which stirs the composting material so that oxygen from the air is made continuously available to the aerobic organisms. In windrow processes, the material is piled in windrows in such a way as to provide for a large mass of voids. Such voids store the initial oxygen supply to encourage the growth of aerobic organisms and serve as channels through which oxygen can pass to continuously replenish the supply demanded for aerobic biological activity.

The void space of a windrow pile is soon seriously reduced by the natural tendency of the material to settle and compact. For this reason, it is necessary in windrow operations to turn the piles periodically, preferably every day or two. Turning restores void spaces and also serves to turn the core material of the pile to the outside so that strictly anaerobic conditions are not permitted to develop.

On small scale windrow studies, it has been demonstrated that the efficiency of the process may be increased by recycling material from older, partially composted windrow piles to the new windrows which are being prepared from freshly ground material. This process of back-seeding provides a large population of organisms which are capable of immediately beginning the digestion of the raw material.

Moisture Content

In both types of composting, moisture content is critical. High moisture contents result in the voids of the material being filled with water and oxygen transfer is prevented from taking place; low moisture levels arrest biological activity. Moisture content is particularly critical in digester operation, and a level of above 60 per cent often results in anaerobic conditions with foul odors and inefficient digestion. Because of the manner in which windrow piles are built, a somewhat higher level of 65 to 70 per cent moisture can be maintained in windrows without the development of undesirable anaerobic conditions. High moisture windrow piles require frequent turning because compaction of the piles reduces void space and produces undesirable anaerobic conditions.

Temperature Rise

When a windrow pile is properly constructed, a rapid rise in temperature is always observed. Under satisfactory conditions, a temperature level of 90 to 100 deg. F. is usually noted after 24 hours, and within two to three days, the temperature level rises to 150 to 170 degrees. These temperatures are self-generated and

result from the activity of the bacterial organisms in utilizing the waste organic material for food. In digesting waste material the bacteria utilize oxygen for a biochemical combination with carbon of the organic material, and in the process produce carbon dioxide. Thus, each bacterial organism can be likened to a small furnace which produces a quantity of heat in utilizing its food material. High bacterial populations produce enough heat to keep windrow piles hot during sub-zero temperatures and for long periods of time. The organic matter is reduced to a lower energy level by composting and odoriferous waste material is changed to fibrous substance with a pleasant earthy smell.

Similar levels of temperature are observed in digester operation. Temperatures of 100 deg. F. and higher are observed on the upper decks of the digester and temperature levels of 150 to 170 deg. F. are noted in the partly digested material on the lower decks. Breakdown seems to be more rapid in digester composting than in windrow composting. The high rate of activity in digester operation results from a fundamental difference between the windrow and digester processes. In digester operation partly composted material is continuously fed into and removed from each deck at such a rate as to maintain high levels of bacterial activity. The theory is that each deck of the digester maintains a bacterial flora which is capable of carrying the composting process to a certain level of completion. Incoming material from an upper deck serves as food for organisms which continue the biological breakdown. Material is continuously removed from each deck and transferred to a lower deck where it serves as food for a new flora of organisms which is capable of carrying the process one step further.

From this brief description, it is apparent that digester operation is mechanically more complex than windrow composting. The most important factors in obtaining good digester operation are proper moisture levels, an adequate supply of oxygen, and the retention of enough heat to maintain the temperature level of the material. Continuous stirring is necessary for proper aeration; but stirring tends to dissipate heat and for this reason, digester design entails the dual problem of insuring adequate oxygen supply without excessive heat losses. Heat losses have made digester operations during cold Michigan winters a difficult mechanical problem but in spite of such difficulties, reasonable temperatures have been maintained in the digester without outside heat sources.

Economic Value of End Product

The actual value of compost for soil conditioning and fertilizing purposes is in question. The usefulness of compost for breaking up clay soils and supplying organic matter to soils which are deficient in humus has been demonstrated. In addition, compost contains two to five per cent nitrogen, one to three per cent phosphorous, and one to two per cent potassium, depending upon the original source of the composted material. With well digested compost, these elements serve as an excellent food for plant life and are unquestionably useful for this purpose. In addition, compost like other organic material has a high capacity for holding moisture and is helpful in this respect. A thin layer of compost when spread upon a moist soil is capable of holding moisture for a considerable period of time.

Unfortunately, the use of compost for such purposes is not an unmixed blessing. The use of partly decomposed compost which is still highly active is undesirable and can be damaging to plant growth. In this case the organisms compete with plant life for the nitrogen in the soil and are usually more efficient in such competition so that plant life suffers. After the organic material is broken down in the soil, its nitrogen content is made available to plant life and is an ideal source for such a purpose since it is readily available and cannot be lost by leaching.

Further soil and economic studies will be necessary before the relative value of compost and other sources of fertilizer material can be properly compared.

Basic Laboratory Studies

The value of combining basic studies with the applied experimentation previously described is best shown by briefly describing some of the fundamental studies which are now being conducted at Michigan State University under a National Institute of Health grant. These studies have been in progress for a period of about 30 months. Special equipment has been designed and built for measuring the quantities of oxygen required for stabilization of waste materials and for studying the effects of temperature, moisture, back-seeding, pH level, bacterial populations, and many other variables. The studies have already provided valuable information with regard to the quantities of oxygen which are utilized by the composting materials and by establishing a level of about 55 per cent moisture as being optimum in the composting process.

Studies on the mechanism of oxygen transfer from the atmosphere to the bacterial organisms involved in the process has yielded further valuable insight into the fundamentals of composting within the next year. In addition, studies have been made upon such variables as oxidation-reduction potential, nitrogen losses, nitrogen transformation, carbohydrate transformation, phosphorus transfer, volatile acids, gas analysis, dewatering, bacteriological organisms, and the development of a yardstick for the composting process.

All of these studies are of fundamental importance in the composting process, and because of their complexity, each study will require long periods of research. The development of a yardstick of composting has been particularly worrisome and even now no truly satisfactory means has been developed for establishing when a material is completely composted and more importantly determining the degree to which material is composted at various stages of the process.

Most commonly, this transformation is measured, when composting garbage or refuse by an initial drop in pH to a very acid level followed by a rise in the hydrogen ion concentration to an alkaline pH level of 8.5 or 9. The change takes place slowly and tends to follow the general course of biological breakdown. Unfortunately, it is not possible to assign a definite level of digestion to a particular pH level and, even more important, it has been demonstrated that materials such as dewatered raw sewage sludge with an initial pH level of 10 or 11 can be satisfactorily composted without passing through an acid stage.

Again, it has been demonstrated by numerous workers that an increase in ash content will be invariably observed as the material composts, yet because of the wide variations in the types of raw material which must be treated, no particular ash content can be considered as indicative of complete composting.

Much work has been done in connection with this difficult problem and research continues along this line at Michigan State University and at other research centers. The development of such yardsticks will be of great practical value to both commercial and laboratory composting.

Summary

Based on the studies at Michigan State University, it is indicated that

composting will be more and more widely used as a process for treating solid organic wastes in the future and that it may very possibly prove to be a more satisfactory method for treating such wastes than any of the methods now available to the sanitary engineer. Because of the absence of adequate machinery and equipment and because of the almost complete absence of technical know-how upon the part of sanitary engineers in general, it cannot be anticipated that composting can be begun on a widespread commercial basis at once. A level of know-how has been reached, however, which should lead to the design of proper equipment in the not too distant future and to the development of more satisfactory methods for composting such wastes.

That composting is a truly remarkable biological phenomenon cannot be denied. Many tons of materia! have been and will continue to be treated by this process, and it is well for all sanitary engineers to follow the development of the composting process with interest since it is a waste treatment process with a definite future.

Sewage & Industrial Wastes Federation Elects Jensen and Watson

Our full report of the Annual Meeting of the Federation of Sewage and Industrial Wastes Associations, in Los Angeles Oct. 8-11, will appear in our next issue. Announcement is here made of the new officers elected by the Federation's Board of Control in session Oct. 7th.

President:
Emil C. Jensen, Chief, Div. of Engineering State Dept. of Health, Seattle, Wash.

Vice-President:
Kenneth S. Watson, Consultant, Water & Waste Control, General Electric Co., Schenectady, N. Y.

Emil Jensen

Kenneth Watson

Mr. Jensen is a registered Professional Civil and Sanitary Engineer. He received his B. S. degree in Civil Engineering from the University of Washington in 1936 and his M. S. in Engineering from Harvard University in 1938. From 1938 through 1941 he served the Yakima County Health Department in Washington as a Sanitary Engineer. In 1941 he became a District Engineer for the Washington State Department of Health and continued in this capacity until 1945 when he assumed his present position as Chief of its Div. of Engineering.

Mr. Watson is a registered Professional Engineer. He is a graduate of West Virginia University with B. S. and M. S. degrees in Chemical Engineering. He served as Chemical Engineer and, later, as Executive Secretary-Engineer of the West Virginia Water Commission. He then became Assistant Director of the Ohio River Valley Water Sanitation Commission. Before going to the General Electric Company, he was a member of the Interstate Commission on the Potomac River Basin and Chairman of its Technical Committee.

Salt Lake's New Water Plant Construction Given State OK

Approval by the Bureau of Sanitation, Utah State Board of Health, cleared the way recently for Salt Lake City to begin construction this summer of its new $2,200,000 water treatment plant. The proposed plant is to be built in Big Cottonwood Canyon.

Although approval by the state opens the way for construction bids and contracts, high water in the canyon was expected to hold up actual construction until June or July. At the time stream flow was expected to be down far enough to permit construction of a bypass channel, the first phase of the project. Opening of the bids was expected early in June.

The project is divided into three parts. The first, to include sedimentation basins, chemical feeding and chlorination equipment, is estimated to cost about $227,000.

The second part includes gravity sand filters estimated to cost $692,-500. The third part, consisting of sludge and wash water disposal systems, is expected to cost $300,-000.

The new plant was designed by Headman, Ferguson and Carollo, consulting engineers of Phoenix, Ariz.

Pickups

From Purdue's *"Sanitary Engineering News"*
Don E. Bloodgood, Editor

You'll find that the man at the top got there because he was at the bottom of a lot of worth-while things.

* * *

Although Cincinnati voters turned down fluoridation by referendum last year, their water now contains approximately 0.8 ppm. as a result of upstream discharges.

* * *

An unusual sideline of Supt. Wendell LaDue is renting out more than 100 boats for fishing on Akron's water supply, Lake Mogodore, an activity which grosses $28,000 to $30,000 a year.

* * *

One of the principal reasons so many Americans suffer from water shortages is their insistance on bargain rates for water. Revenues from sale of water are insufficient to support the development of adequate supplies.

* * *

Some people grow when given responsibility; others merely swell.

Gutschick Joins National Lime Association

Kenneth A. Gutschick, former Associate Editor," Rock Products", has joined the staff of the National Lime Association, Washington, D. C., as Manager of Technical Service.

A native of Chicago, Mr. Gutschick attended the University of Chicago where he obtained his B.S. and M.S. degrees in 1949 and 1950. Following college, he taught geology and physiography for two years at the University of Notre Dame; spent one year with Material Service Corporation, Chicago, in production; nearly three years as Field Editor for "Pit and Quarry" magazine. In this latter capacity and in his recent position as Associate Editor for "Rock Products," Mr. Gutschick authored many articles.

In his new position, Mr. Gutschick will devote his activities to research, promotion, and publicity on burned lime products in all fields as well as being a general assistant to Robert S. Boynton, General Manager, National Lime Association.

Introducing

Our New Executive Vice President

THE SCRANTON PUBLISHING CO., Inc. is pleased to announce that Dr. George E. Symons has become a member of the corporation's Board of Directors and on December 1, 1956, will become Executive Vice President and Editorial Director of the Corporation and its publishing enterprises.

In his new position, Dr. Symons will supervise all fiscal, and promotion operations and editorial production of *Water & Sewage Works, Industrial Wastes, Modern Highways,* and the Reference & Data Number of Water & Sewage Works. Dr. Symons will also supervise the development of market studies and will be Co-Editor of the annual Reference & Data Number of Water & Sewage Works. He will continue to write feature articles on water, sewage, and industrial waste practices.

Dr. Symons is well known in sanitary engineering having been Associate Editor of *Water & Sewage Works* from 1943 to 1950; Managing Editor 1950-51, and a Feature Writer since 1953, as well as Co-Editor of the Reference & Data Number. He was author of the column, "Here and There with Doc Symons" and is the author of the series of articles on "Water Works Practices", currently appearing in *Water & Sewage Works.*

For the past five years, Dr. Symons has had his own office in Larchmont, N. Y. where he practiced as a Consultant and Technical Editor and free lance writer. Among his regular clients were B-I-F Industries, Inc. of Providence, R. I., the Pacific Flush Tank Co., of Chicago, the *Cast Iron Pipe News* and *Public Works Magazine* and Nussbaumer, Clarke and Velzy, Cons. Engrs. During 1954-55 he was also on the staff of the Research Division of New York University's Coll. of Engng. as Res. Assoc. in Civ. Engng.

"Doc" Symons started in the field of Sanitary Engineering, as a filter plant operator and chemist for the Interstate Water Co. in Danville, Ill. where his father was chief engineer. Two years of chemical engineering study at the Univ. of Wisconsin was followed by a year as chemist at the sewage treatment plant in Decatur, Ill. under the tutelage of Dr. W. D. Hatfield. Then "Doc" returned to school for six more years at the Univ. of Illinois where he also worked for the Ill. State Water Survey as a research chemist under Dr. A. M. Buswell.

From the Univ. of Illinois, Dr. Symons received a B. S. with honors in chemistry, M. S., and Ph. D., majoring in sanitary engineering chemistry and bacteriology. Following his doctorate, he taught for one year as an Instructor at the Univ. of Illinois, before he joined the Freeport Sulfur Co. as a research chemist.

In 1935, Dr. Symons served on the staff of Greely and Hansen, Consulting Engineers, on a sewer project in Evansville, Ind. and in 1936 Dr. Symons went to Buffalo, N. Y. to direct the laboratory studies in connection with the design of the intercepting sewer system and treatment works. In 1938, he became Chief Chemist of the Buffalo Sewer Authority. During World War II, he also served as acting Asst. Supt. of the Treatment Works, until he resigned in 1943 to become Associate Editor of *Water & Sewage Works.*

In Buffalo, Dr. Symons was associated with Canisius College and the Univ. of Buffalo Med. School as a Lecturer. Dr. Symons was Consultant to the Buffalo Sewer Authority until 1950 and co-authored the "Buffalo Formula" adopted for charging for industrial wastes. He also directed studies on industrial waste problems and authored the plan for abating industrial waste pollution in the Buffalo River.

Dr. Symons began his writing career as co-author of an article on sludge digestion research in 1925. He has authored or co-authored more than 135 bylined articles on research, teaching, and operation of water, sewage and industrial waste plants. Many of these have been papers at technical meetings. He has appeared as an after dinner speaker at many association meetings and has staff-authored more than 125 technical meeting reports, book reviews, editorials and more than 150 columns.

A licensed professional engineer in N. Y. State, Dr. Symons also holds a Grade I Operators Certificate for both water and sewage plants in N. Y. State. He is a member of ACS, AICHE, AIDIS, APCA, APHA (Fellow), ASCE, AWWA, NEWWA, NSPE and NYSIWA.

Dr. Symons has served as Secy. of the Buffalo Sect. of ASCE, Secy. of the West. N. Y. Sect. of AICHE, and Secy. of the West. Sect. of NYSIWA. He has been Prog. Chair., Vice Pres. and President of NYSIWA and a Director, representing NYSIWA in the Federation. At the present time he is Chairman of the Federation Publications and Program Committee. At the N. Y. Sect. AWWA meetings he has been conducting a "Water Works School" for the past three years.

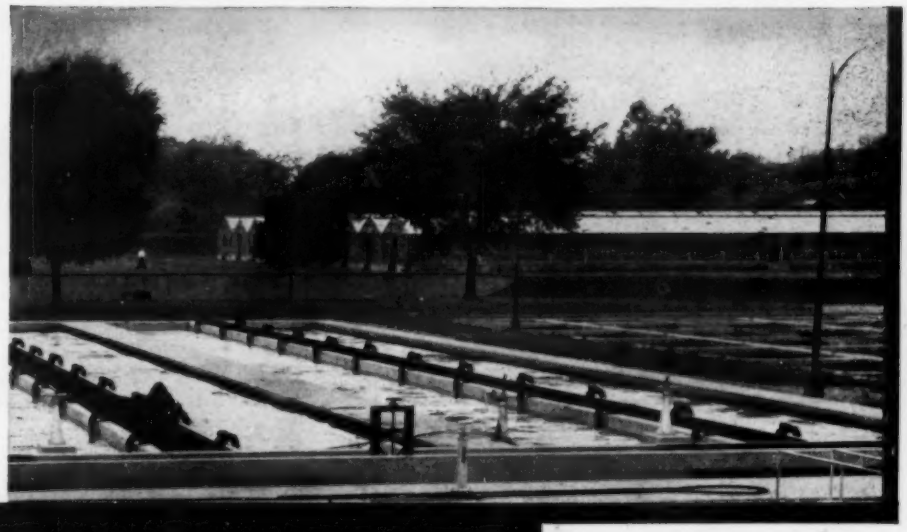
Other extra-curricular activities include: Ed. of the 9th Ed. of "Standard Methods for the Examination of Water and Sewage"; Edit. Coordinator of the 2nd Ed. of AWWA "Manual of Water Quality and Treatment"; and Co-Compiler, with W. H. Wisely, of the "20 Year Index of Sewage Works Journal" for FSIWA.

Dr. Symons' biography is listed in the Supplement to Who's Who in America, Who's Who in Engineering, Chemical Who's Who, and American Men of Science. He is a member of Phi Kappa Sigma and Alpha Chi Sigma fraternities and the honorary fraternities, Sigma Xi, Phi Lambda Upsilon and Mu San. In 1940 he received the Kenneth Allen Award for Research from the NYSIWA.

In his new position, Dr. Symons will be located in New York City; he will attend various conventions in the interest of the company and its magazines.

"from Chicago"

the aeration story



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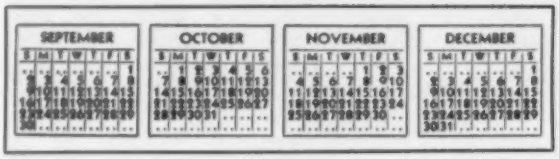
Meetings Scheduled

1956



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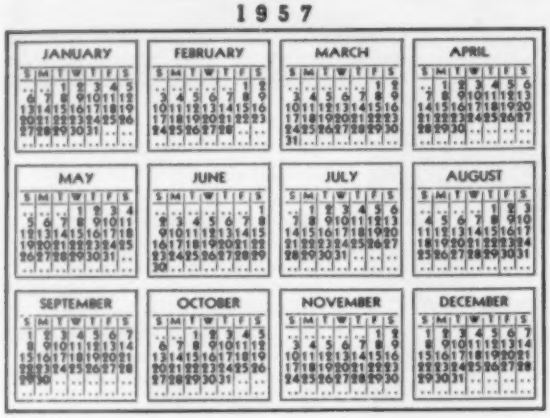

Nov. 11-14—Daytona Beach, Fla. (*Daytona Plaza Hotel*)
FLORIDA SECTION, A.W.W.A., Secy. Jay D. Roth, City Hall, Miami Beach 39, Fla.

(*Jointly With*)

FLORIDA SEWAGE & INDUSTRIAL WASTES ASSN., M. E. Dawkins, Secy.-Treas., % Reynolds, Smith & Hills, P.O. Box 4817, Jacksonville 1, Fla.

Nov. 12-14—Charlotte, N. C. (*Hotel Charlotte*)
NORTH CAROLINA SECTION, A.W.W.A.,

(*Jointly With*)

NORTH CAROLINA SEWAGE & INDUSTRIAL WASTES ASSN., W. E. Long, Jr., Secy.-Treas., Box 2091, Raleigh, N. C.

Nov. 12-16—Atlantic City, N. J. (*Convention Hall*)
AMERICAN PUBLIC HEALTH ASSN., Secy., Dr. Reginald M. Atwater, 1790 Broadway, New York, N. Y.

Nov. 15-16—Detroit, Michigan (*Hotel Statler*)
NATIONAL ASSOCIATION OF CORROSION ENGINEERS, NORTH CENTRAL REGION, A. B. Campbell, Exec. Secy., 1061 M & M Bldg., Houston 2, Texas.

Nov. 16—Columbia, S. C. (*Jefferson Hotel*)
SOUTH CAROLINA SEWAGE & INDUSTRIAL WASTES ASSN., George A. Rhame, Meeting Committee, S. C. State Board of Health, Columbia, S. C.

Nov. 26-28—Colorado Springs, Colo. (*Broadmoor Hotel*)
ROCKY MOUNTAIN SECTION, A.W.W.A., Jack W. Davis, Secy., Johns-Manville Sales Inc., Denver, Colorado.

Dec. 3-7—Stillwater, Oklahoma (*Oklahoma A & M College*)
13TH ANNUAL OKLAHOMA WATER & SEWAGE SHORT COURSE, H. M. Crane, Secy.-Treas., Okla. State Dept. of Health, 3400 North Eastern, Oklahoma City, Okla.

Dec. 9-12—Boston Mass, (*Statler Hotel*)
AMERICAN INSTITUTE OF CHEMICAL ENGINEERS Annual Meeting. F. J. Van Antwerpen, 25 W. 45th Street, New York 36, N. Y.

STATEMENT OF OWNERSHIP

Statement Required by the Act of August 24, 1912, as amended by the Acts of March 3, 1933, and July 2, 1946 (Title 39, United States Code, Section 233) showing the ownership, management, and circulation of

Water & Sewage Works

published monthly at Pontiac, Illinois for October, 1956.

1. The names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Edward Scranton Gillette, 185 N. Wabash Av., Chicago 1, Illinois; Editor, Linn H. Enslow, 155 East 44th St., New York 17, N. Y.

2. The owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding 1 percent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a partnership or other unincorporated firm, its name and address, as well as that of each individual member, must be given.) Scranton Publishing Company, Inc., 185 N. Wabash Ave., Chicago 1, Illinois; E. S. Gillette, 185 N. Wabash Ave., Chicago 1, Illinois; C. T. Gillette, 185 N. Wabash Ave., Chicago 1, Illinois.

3. The known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages, or other securities are: None.

4. Paragraphs 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

Edward S. Gillette, Publisher

Sworn to and subscribed me this 17th day of October, 1956. Arthur L. Hudson, Notary Public in and for Los Angeles County, State of California. My commission expires April 26, 1957.

As the number of installations of Walker Process DIFFUSAIR SPARGERS increases, in sewage and industrial waste treatment, it becomes apparent that former conservative claims regarding results obtainable are simply statements of fact.

DIFFUSAIR SPARGERS have demonstrated time and again over the past months that they are not just "equal to" but actually superior to other types of air-diffusion devices . . . proving in full-sized plant tests that they

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DELIVER MORE OXYGENATION EFFICIENCY AND HIGHER RATE OF TANK TURNOVER
DO NOT BUILD UP BACK PRESSURE
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Two aeration bays at Hyperion (L.A., Calif.) Sewage Treatment Plant equipped with DIFFUSAIR SPARGERS. Remaining bays utilize another type of diffuser. Studies have been made on Oxygenation and Maintenance costs on DIFFUSAIR SPARGERS. All aeration bays at Hyperion are equipped with a foam-breaking spray system to control this nuisance with which Hyperion has had a great deal of experience.

G. A. Parkes, Chief Engr. & Gen'l. Supt.

Bulletin 22S61 presents complete details on DIFFUSAIR SPARGERS and includes discussions on the use of aeration in the various steps in sewage and waste treatment. Write for your copy.

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Ralph A. Hoot, Plant Supt.

San Antonio selected DIFFUSAIR SPARGERS for their new plant addition. SPARGERS are installed in two new bays each 350'x29'10"x15'0" W.D. Original bays are equipped with diffuser tubes on pivotal frames and also fixed plates.

W. N. Wells, Plant Supt.

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Dec. 12—Pittsfield, Maine
MAINE WATER UTILITIES ASSOCIATION, Gerard F. Laurin, Secy.-Treas., 89 Western Avenue, Augusta, Maine.

1957

Jan. 17-18—New York City, N. Y. (*Hotel Belmont Plaza*)
NEW YORK SEWAGE & INDUSTRIAL WASTES ASSN., Exec. Secy. R. C. Sweeney, State Dept. of Health, 21 North Broadway, White Plains, N. Y.

Feb. 6-8—Indianapolis, Indiana (*Sheraton-Lincoln Hotel*)
INDIANA SECTION, A.W.W.A., Secy., Robert J. Becker, Indianapolis Water Co., 113 Monument Circle, Indianapolis 6, Ind.

Feb. 18-22—Jackson, Miss.
AMERICAN SOCIETY CIVIL ENGINEERS, Exec. Secy., W. H. Wisely, 33 W. 39th Street, New York 18, N. Y.

Mar. 3-8—College Station, Texas (*Texas A. & M. College*)
TEXAS WATER & SEWAGE WORKS ANNUAL SHORT SCHOOL, Secy., V. M. Ehlers, 2202 Indian Trail, Austin 3, Tex.

Mar. 13-15—Atlantic City, N. J. (*Traymore Hotel*)
NEW JERSEY SEWAGE & INDUSTRIAL WASTES ASSN., Michael S. Kachorsky, Secy-Treas., P. O. Box 68, Manville, N. J.

Mar. 17-20—Charleston, S. C. (*Francis-Marion Hotel*)
SOUTHEASTERN SECTION, A.W.W.A., Secy. N. M. deJarnette, Div of Water Pollution Cont., State Dept. of Pub. Health, 245 State Office Bldg., Atlanta 3, Ga.

Mar. 18-20—Little Rock, Ark. (*Marion Hotel*)
ARKANSAS WATER & SEWAGE CONFERENCE, C. W. Oxford, Secy.-Treas., University of Arkansas, Fayetteville, Ark.

Mar. 20-22—Chicago, Ill. (*LaSalle Hotel*)
ILLINOIS SECTION, A.W.W.A., Secy., Dewey W. Johnson, Cast Iron Pipe Research Assn., 122 S. Michigan Ave., Chicago 3, Ill.

Apr. 4-6—Mesa, Arizona (*Maricopa Inn*)
ARIZONA SECTION, A.W.W.A., Secy., H. C. Bigglestone, Board of Fire Underwriters of Pacific, 1106 Luhrs Tower, Phoenix, Ariz.

Apr. 5-6—Great Falls, Montana (*Rainbow Hotel*)
MONTANA SECTION, A.W.W.A., Secy., Arthur W. Clarkson, State Board of Health, Helena, Montana

Apr. 10-12—Wichita, Kansas (*Broadview Hotel*)
KANSAS SECTION, A.W.W.A., Secy., Harry W. Badley, Neptune Meter Co., 119 W. Cloud St., Salina, Kansas
(*Jointly With*)
KANSAS SEWAGE & INDUSTRIAL WASTES ASSN., James F. Aiken, Jr., Secy-Treas., Dept. of Public Health, 407 City Bldg., Wichita 2, Kansas

Apr. 10-12—Elmira, New York (*Mark Twain Hotel*)
NEW YORK SECTION, A.W.W.A., Secy, Kimball Blanchard, Rensselaer Valve Co., c/o Ludlow Valve Mfg. Co., 11 W. 42nd St., New York 36, N. Y.

Apr. 24-26—Lincoln, Neb. (*Cornhusker Hotel*)
NEBRASKA SECTION, A.W.W.A., Secy., John E. Olsson, 408 Sharp Bldg. Lincoln, Neb.

Apr. 24-27—San Diego, Calif. (*Hotel Not Announced*)
CALIFORNIA SEWAGE & INDUSTRIAL WASTES ASSN., R. J. Barletta, Secy.-Treas., 719 South Loara St., Anaheim, Calif.

May 2-4—Tacoma, Wash. (*Winthrop Hotel*)
PACIFIC NORTHWEST SECTION, A.W.W.A., Secy., Fred D. Jones, Room 305 City Hall, Spokane, Wash.

May 12-17—Atlantic City, N. J. (*Convention Hall*)
A.W.W.A. CONVENTION, Secy., Harry E. Jordan, A.W.W.A. Assn., 2 Park Ave., New York 16, N. Y.

June 3-7—Buffalo, N. Y.
AMERICAN SOCIETY CIVIL ENGINEERS, Exec. Secy. W. H. Wisely, 33 W. 39th Street, New York 18, N. Y.

Canton Gets a New Concrete Distribution Line

This crew is putting in the fourth piece of pipe in a 4500-foot concrete feeder line for Canton, Ohio. The line runs from the north corporation line south on Broad, west on 8th, and south on Wertz to 3rd where it ties into an existing 12-inch line. Along the route the new line feeds distribution lines of 6, 8 and 12 inches.

The line went in easily and with little interference to traffic. The backhoe in the picture dug the trench and laid the pipe for the entire line. A supply of short lengths and bevel adapters was kept on the job to make on-the-spot turns to clear obstructions. A bevel adapter is a small special made up of a bell ring and spigot ring set back to back at an angle of 2° to 4°.

The line has been tapped three times since it was laid in 1954. The ¾" taps were made by Canton Waterworks crews using their regular equipment and new-design fixtures furnished by the manufacturer of the pipe. The entire line is 24-inch prestressed concrete cylinder pipe made by Price Brothers Company, Dayton 1, Ohio. Price has plants in Dayton, Cleveland and Miami, Fla.

Price

(Advertisement)

• If interested in equipment or literature mentioned below, mail a Reader Service Card with your name, address, and item key number.

W&SW

New Equipment

Excalibur For Sludge Collector Flights

1101

Overseas Lumber Co., New York, N. Y., is introducing to this country, South American Timber known as Excalibur that is especially suited for use on sludge collector or scum skimming flights.

According to the company, the advantages offered by Excalibur are: Durability, superior to iron and steel when in contact with water; strength, doubly strong as domestic woods; maintenance, no painting, coating, treatment, or other protection necessary; decay, permanently preserved against rot, ants, termites, and other parasites; corrosion, the tight grain presents a nonabsorbant, corrosion-resistant surface; cleanliness, high density prevents absorption of corrosive or malodorous agents; abrasion-resistance, one of the hardest and toughest woods available in the world.

Excalibur will not tend to work loose around bolt holes, nor are there any agents in it that would tend to cause corrosion of the fastenings. The company will furnish excalibur according to the dimensions required.

Huge WHEELER-ECONOMY AXIAL FLOW PUMPS

Designed to Establish a Syphon in Pioneer Application at Donaldsonville, La.

To establish water supply from the Mississippi River to the vast area of Bayou La Fourche, required the utmost ingenuity and cooperation between the State of Louisiana engineers and Economy Pumps engineers. Three 42" x 48" Wheeler-Economy AFV Axial Flow Pumps were selected to do the job. Design capacity is 45,000 GPM at 17' TDH. But when these pumps operate as a syphon they move 65,000 GPM. Motors are 250 HP operating at 514 RPM. Pumps in operation run 24 hours a day.

It is believed this is the first application of pumps of this design to pass such a high volume of water on the syphon principle. Infinite care in planning and construction is typified by the exact length each pump had to meet—51'9⅝" from underside of mounting plate to end of suction bell. Moreover, every increment assembled in the field had to be made airtight by skilled Wheeler-Economy specialists to make possible the necessary vacuum.

Success was largely assured by Wheeler-Economy's extensive manufacturing facilities in Philadelphia. Here, in one of the largest test pits in the industry, witness tests were made by the State of Louisiana and the contractor to prove pump performance before delivery.

You, too, can rely on Wheeler-Economy for help on complex pumping problems, dependable delivery and performance that lives up to promise.

WES13

WHEELER-ECONOMY PUMPS

C. H. WHEELER MANUFACTURING CO., ECONOMY PUMP DIVISION
19TH AND LEHIGH, PHILADELPHIA 32, PA.

Chemical Grout Solves Sewer Infiltration Problem

1102

The Chemject Corp., Chicago, Ill., has announced that the injection of Chemject grout has eliminated excessive ground water seepage into a 2,000 foot section of 18 inch vitrified clay line in Hollywood, Fla., while the line remained in full and continuous operation.

First step in the procedure is to locate the leak on the length and periphery of the pipe. Then an injection point is jetted or driven at the proper location and to the proper elevation adjacent to the point of infiltration. The set time of the Chemject grout is controlled so that gelation will take place as the grout begins to pass through the leak. The injected grout penetrates the soil adjacent to the pipe and upon gelation renders the entire mass impervious. In the cases of extreme infiltration where a sizable void has been created adjacent to the leak, a quantity of properly sized aggregate is placed before grouting.

The main advantages claimed for this technique are: Work can be performed from the surface, without excavation; no interruption of service; and paving above the sewer need not be disturbed.

Get Faster, More Efficient Sewage Treatment

WITH THE

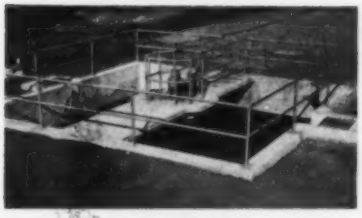
INFILCO *HIGH-RATE* LINE

All INFILCO sewage-treatment equipment is designed for utmost speed and efficiency of operation in the smallest possible space. The line is the most complete in the field, offering units for your every need. Here are a few typical examples. Write today for free literature of interest to you. There is no obligation.

Inquiries are invited also on all other water and waste treating problems, including precipitation, coagulation, sedimentation, filtration, flotation, ion exchange and biological processes.

COMMINUTION

GRIDUCTOR® Comminutors for sewage screening and cutting offer the advantage of straight channel installation plus double-end adjustable cutter teeth which may be resharpened and realigned for longer effective life. ***Request Bulletin 5100.***



MIXING

VORTI® Mixers provide rapid turbulent agitation throughout the body of liquid by controlled, multi-directional circulation. They combine the advantages of rapid treatment in minimum space, low power consumption and efficient distribution in a compact unit.

"VORTI" Mixers may be used for continuous or batch agitation in either rectangular or round basins. ***Request Bulletin 700.***

COAGULATION

VORTI-FLOC® Coagulators provide gentle but thorough agitation, without short circuiting, to build up floc particles to optimum size, quickly, for effective liquid solid-separation.

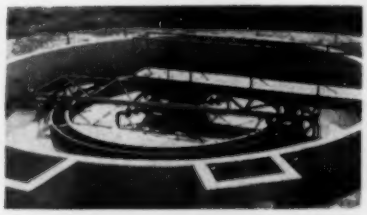
"VORTI-FLOC" units are used in round or square basins. Multiple units operate in rectangular basins, in which the impellers may be mounted, vertically or horizontally, upon a single shaft. ***Request Bulletin 700-5401.***

FLOTATION

The **SEDIFLOTOR®** Clarifier is particularly effective in the high-rate treatment of sewage and wastes containing greases, oils, fibers, colloids and light suspended solids. Heavier solids are removed by scrapers. The "SEDIFLOTOR" unit may be installed in either circular or rectangular basins. ***Request Bulletin 6051.***

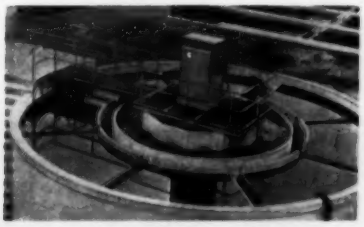
SEDIMENTATION

INFILCO clarifiers provide for the effective removal of suspended solids and surface scum from liquids. The WS Clarifier is suitable for small basins. For large basins, the BF and PDR Clarifiers are recommended. ***Request Bulletin 800/6,000.***



MIXING AND SEDIMENTATION

The **CYCLATOR®** Clarifier Type AR has special applications in the treatment of domestic sewage by biological oxidation. The basin has a central compartment containing COLAFLEX® diffusers, in which the sewage is mixed, aerated and coagulated. ***Request information.***



ACTIVATED SLUDGE TREATMENT

The **AERO-ACCELATOR** (Trade Mark) activated sludge plant is high-rate process equipment based upon established principles of hydraulics and biochemistry. It provides a compact, highly efficient multi-purpose plant which combines rapid and continuous biological action and clarification, efficient operation at high loadings, stability under shock conditions, and great economy of space. ***Request Bulletin 6510.***

FLOATING COVERS

INFILCO Floating Covers are offered in both scum submergence and gas holder types, with necessary auxiliary equipment. ***Request Bulletin 6700.***

INFILCO

5438

INFILCO

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★ ★

*THE **ONE** COMPANY OFFERING EQUIPMENT FOR **ALL** TYPES OF WATER AND WASTE TREATMENT*

• If interested in equipment or literature mentioned below, mail a Reader Service Card with your name, address, and item key number.

Larger Capacity Liquid Meters

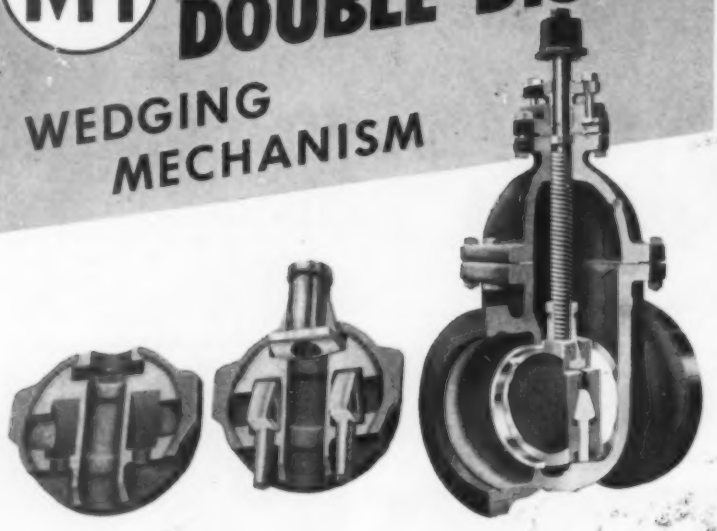
1103

Rockwell Manufacturing Co., Pittsburgh, Pa., has introduced a new line of crank-controlled Rotocycle liquid meters designed for larger capacity, longer life, quiet operation and reduced maintenance costs.

The new meters, utilizing the basic operating principle of standard Rotocycle meters, feature a new crank-type linkage for gear control. Three models with flow capacities ranging from 400 to 1,000 GPM are available.

The new linkage cuts down the number of parts, makes for stronger control of vane positioning and therefore increases capacity and life expectancy. The complete rotor assembly consists of a combination back bearing plate-control plate assembly, with four control arms and bushings.

MH DOUBLE DISC WEDGING MECHANISM



Simple design and rugged construction are outstanding features of the double disc gate assembly in M & H Valves. The gate consists of 2 bronze faced discs, 1 integral stem nut and spreader, and 2 direct-acting bronze spreaders.

When the valve is opened, the stem nut spreader and the direct-acting spreaders simultaneously release the pressure of the disc against the seats. This allows the dics to move laterally away from the seats and rise easily. When the valve is closed, the action of the discs and spreaders is simply reversed.

There is no sliding action of the discs on the seats either in opening or closing. With certain refinements, this mechanism is incorporated in M & H Square Bottom Valves which are especially designed for throttling purposes. Write or wire

M&H VALVE AND FITTINGS COMPANY
ANNISTON, ALABAMA

Transistorized Leak Detector

1104

Fisher Research Laboratory, Inc., Palo Alto, Calif., has developed a new transistorized M-Scope leak detector. The use of 5 miniature hermetically sealed transistors make it possible to provide several times more amplification of the leak sounds than in previous models. At the same time weight, size and battery requirements are greatly reduced so that the new leak detector is truly a portable instrument.

The weight is only 7 pounds complete as against an average of 30 to 35 pounds for conventional type units.

A built-in battery test circuit is included for easier maintenance, and controls and operation have been streamlined and simplified.

Compatible Coal Tar Primer

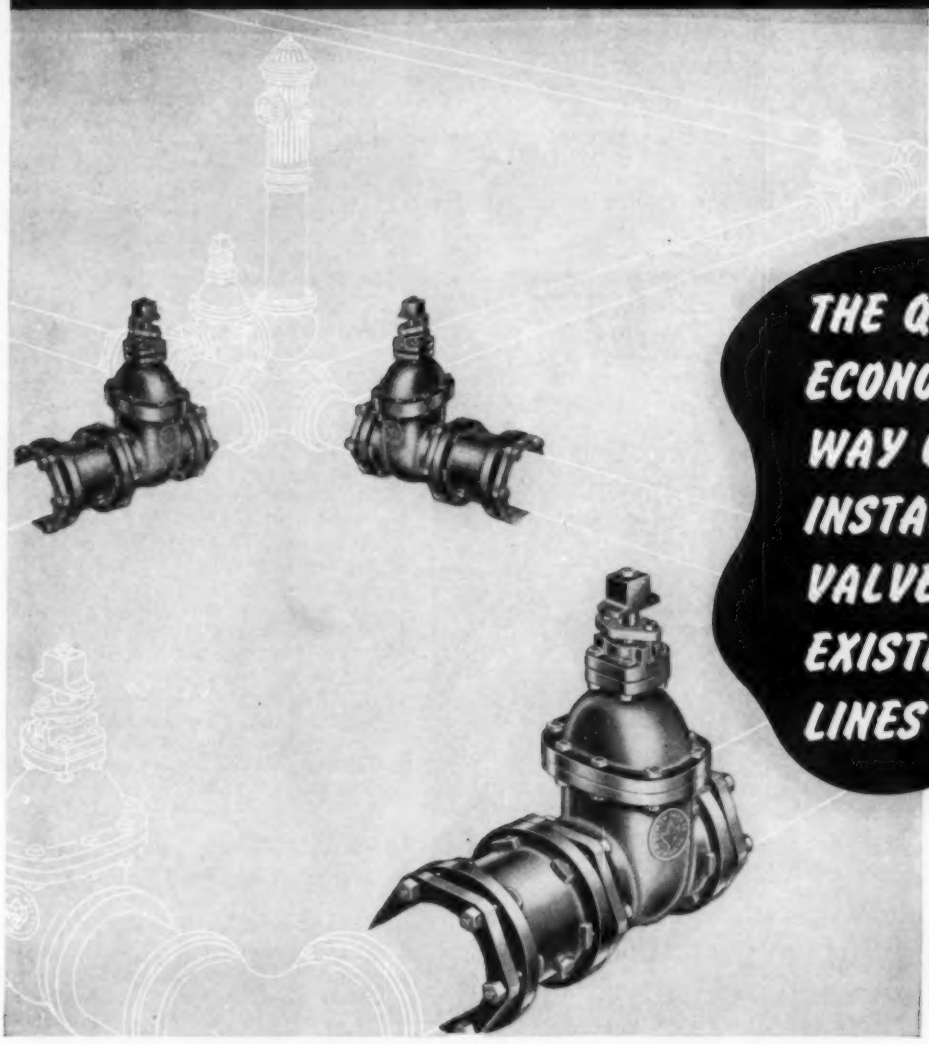
1105

The Tapecoat Company, Evanston, Ill., has developed a new priming solution especially for use with Tapecoat coal tar protective coatings.

This new product, known as TC Primecoat, is designed to give users a primer that is compatible with the coal-tar-pitch base used in Tapecoat protective materials.

TC Primecoat is available in 1-gallon cans, packed 2 gallons to the carton. Application coverage is 400 square feet per gallon, it is stated.

SMITH CUT-IN VALVE AND SLEEVE



THE QUICK ECONOMICAL WAY OF INSTALLING VALVES IN EXISTING LINES

The Smith Mechanical Joint Cut-in Valve and Sleeve is truly the answer to the problem of installing gate valves in existing piping which can be relieved of pressure. The design reduces size of excavations, installation time and in-service cost to the minimum. Two substantial stop screws lock the Valve and Sleeve securely in place.

The Cut-in Valve and Sleeve can be installed on any standard class of cast iron pipe. Molded rubber gaskets fit into machined "Stuffing Box Type" joints, which are permanently leak proof. Smith Cut-in Valves are manufactured in compliance with the A.W.W.A. gate valve specification. Write for Bulletin MJ2.

54

FIRE HYDRANTS · VALVES · SINCE 1896

THE A.P. SMITH MFG. CO.

EAST ORANGE, NEW JERSEY

New-Design Sewer Emptier

1106

City Tank Corp., Corona, L. I., N. Y., manufacturers of Roto-Pac refuse loaders, is now offering a truck-mounted sewer, cespool and gully emptier. Called the "Karrier-Yorkshire" the unit operates on a new principle described as "piston compression and discharge," which is claimed to remove sludge and water quickly, efficiently and economically. Under this process, the sewer or cesspool contents are drawn into the unit's sludge compartment until the tank is full. At

this point, a hydraulic ram moves a pusher plate to the rear of the tank, forcing the dirty water into a surplus water compartment and compressing the solid sludge against the rear door of the tank. Thus, the dirty water, but not the sludge is then returned to the sewer and the process repeated until the tank is full of solid, compacted sludge.

This simply constructed sludge tank will hold over 300 gallons of compacted sludge. A float valve automatically closes the suction valve when the surplus water compartment is full. This compartment holds over 50 gallons.

The suction hose works by means of a crane which turns through 360 degrees and enables the operator to clean sewers from either side of the street or from the front or back of the truck.

Water-Base Antifoam Agent

1107

National Aluminate Corp., Chicago, Ill., has developed a water base liquid antifoam agent.

Called Nalco 71-K, it was developed especially for control of foaming under conditions where oil-based formulations have proved only partially successful. According to the company, it has proved highly effective in these applications both in controlling foam and eliminating entrapped air.

The new product is composed of antifoam agents in an aqueous-solvent carrier. It contains self-emulsifying and emulsion stabilizing materials which promote rapid dispersion of the chemical foaming systems.

"OZENE" New Solvay Trade Name For Orthosolv

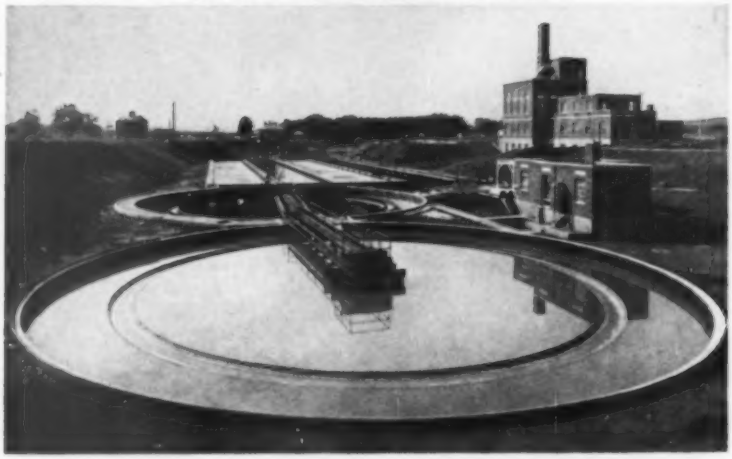
1108

The Solvay Process Division, Allied Chemical & Dye Corporation, New York, N. Y., has announced "Ozene" as the new trade name for the odor suppressant and solvent-cleaner previously called Orthosolv.

The composition, properties and uses of the product remain the same—"Ozene" is an emulsifiable ortho-dichlorobenzene compound that effectively controls offensive odors from a wide variety of sources including garbage and refuse disposal, sewage treatment, industrial wastes, drainage ditches, kennels, storm sewers, market area streets and refuse cans and trucks.

"Ozene" is also an efficient solvent for the removal of heavy sludge in fuel oil tanks, and greases, tars and oils from engines, floors, machinery, tools and metal parts.

Hardinge CLARIFIERS for circular tanks



Two Hardinge 100'-diameter, center-column final clarifiers at the municipal sewage disposal plant in York, Pennsylvania. (Albright and Friel, consultants)

Hardinge Clarifiers and Thickeners are being used in:

- SEWAGE TREATMENT PLANTS for primary and final clarification and sludge thickening.
- INDUSTRIAL WASTE TREATMENT of all types.
- WATER TREATMENT, industrial and public.

A wide selection of sizes and arrangements is offered:

- Normal duty and "Auto-Raise" heavy duty mechanisms.
- Beam, truss and center-pier supported units.
- Side feed and under feed.
- Spiral and segmented rakes.
- Mechanical, hydraulic or electrical overload protection.

Detailed specifications for all types and sizes are available upon request. Bulletin 35-D-15

HARDINGE
COMPANY, INCORPORATED

YORK, PENNSYLVANIA • 240 Arch St. • Main Office and Works

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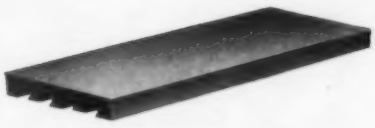
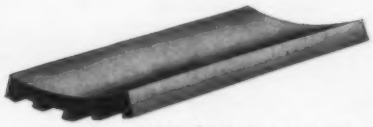
Amvit CLAY LINER PLATES *resist abrasion*

provide smoother flow, added protection





Standard size 9" x 24"
Other sizes upon request

● For *complete* protection of concrete pipe sewers, industrial sewers, culverts, acid vats, sewage treatment tanks, neutralizing baths and laboratory and industrial walls and floors choose and use *Amvit* clay liner plates.

They are specially manufactured to meet all application requirements which entail resistance to acids, alkalies and chemical reaction.

Amvit clay liner plates, hardened, glazed, smooth, acid-proof and durable, permanently bond and lock to masonry and concrete work. They install easily to concrete forms and are sized according to standardized specifications for uniform spacing.

For more information, write or call for our detailed booklet on Amvit liner plates. American Vitrified Products Company, National City Bank Building, Cleveland, Ohio, or our office nearest you.

102" reinforced concrete pipe lined with Amvit curved clay liner plates being installed in a combination storm and sanitary sewer.

SINCE 1900

American Vitrified Products Company

CLEVELAND, OHIO

MANUFACTURERS of: Clay pipe, flue liners, clay liner plates and concrete pipe.

Plants Across the Nation... Brazil, Indiana • Chicago, Illinois • Cleveland, Ohio • Crawfordsville, Indiana • Detroit, Michigan • East Liverpool, Ohio Fenton, Michigan • Grand Ledge, Michigan • Lisbon, Ohio • Los Angeles, California • Milwaukee, Wisconsin • South Bend, Indiana • Uhrichsville, Ohio

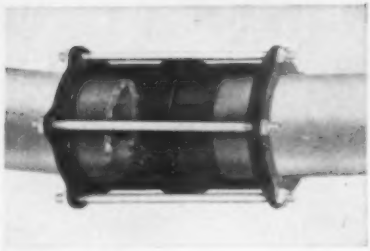
• If interested in equipment or literature mentioned below, mail a Reader Service Card with your name, address, and item key number.

Coupling Repairs Misalignment Breaks

1109

Smith-Blair, South San Francisco, Calif., has developed an improved coupling for repairing misalignment breaks in water, gas or oil pipelines. It is called a Flexible Cut-In coupling and is applicable to cast iron, asbestos-cement or steel pipe, and is installed with the pipe in place. This coupling acts as a double coupling replacing twice the length of pipe cut out.

A unique feature of this coupling is a dual sleeve plus a centering ring. When the break in the pipe is cut out sufficiently for one sleeve to be placed, all parts



of the cut-in coupling are then assembled to repair-connect the pipe while in place. The cut-in coupling consists of two sleeves, two gaskets, two flanges and a centering ring complete with gaskets which are tightened, as an assembly, on the pipe with through bolts.

The pipe can be out of alignment over 6° and be repair-connected in place. The cast units are made with ductile iron flanges and cast iron sleeves to resist corrosion so that the flexible coupling will last as long as the pipeline on which it is installed. Sizes 2 through 12-inches are now in production.

Hydraulic Switch For Valve Operators

1110

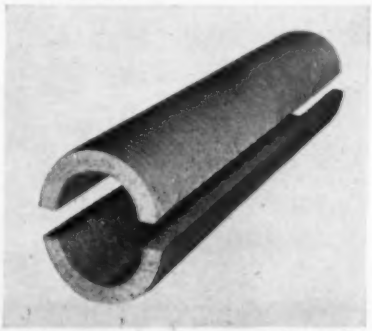
Infilco Inc., Tucson, Arizona, has developed a type A-D hydraulic switch for the control of hydraulic cylinder operated valves of all types.

The new switch is a pneumatically actuated dual diaphragm, four-way control valve which can be mounted close to the cylinders. Actuating three-way air valve or valves may be remotely placed. It may be used with a "controlled" valve position indicator on an operating panel or in a console. It can be used for open-shut operation or for open-hold-shut operation.

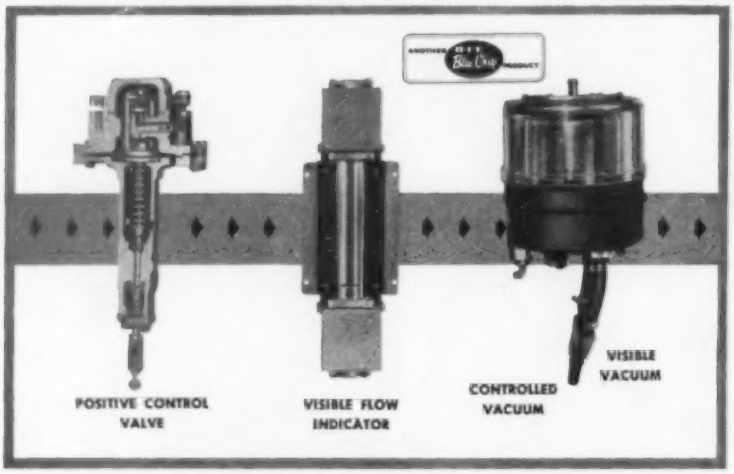
Wide Range Molded Pipe Insulation

1111

Keasbey & Mattison Co., Ambler, Pa., has just developed Kaytherm, a new wide temperature range molded insulation designed for use on steam and heated process piping. This effective low conductivity insulation withstands pipe temperatures up to 1350° Fahrenheit.



Kaytherm, which is produced in half-cylindrical sections and segments 36 inches long, is easy to install requiring only simple encircling metal bands to fasten two mating sections to a pipe. It can be cut easily and worked with ordinary tools. This wide temperature range pipe insulation comes in a variety of thicknesses ranging from 1-inch to 4-inches and will accommodate pipes up to 33 inches in diameter.



IN CHLORINE GAS FEEDERS . . .

LOOK FOR KNOW-HOW

Here's proof of good chlorine feeder design! The gas flow path shown in this Builders-Providence flowgram is the shortest offered by any manufacturer of chlorination equipment . . . and we invite comparison! Good design means maximum dependability (to the consulting engineer) . . . ease of installation (to the contractor) . . . and easy operation, low upkeep, and low operating cost (to the operator).

Our design offers all these and more. For added safety . . . there are no springs or piloted parts in contact with chlorine, no packed valve stems to leak and destroy feeding accuracy . . . and the simplicity of the entire system means better operation with less maintenance.

These superior features did not just happen — but are drawn from the vast reservoir of B-I-F application knowledge and experience gained as the major manufacturer of flow metering, and control equipment for WATER, SEWAGE, and WASTE TREATMENT PLANTS. Many consulting engineers have profited by the valuable assistance received from B-I-F specialists. Our policy of continuing research and development has produced the most comprehensive, service-proven line available . . . and thousands of superior performance records reflect our broad design and manufacturing experience.

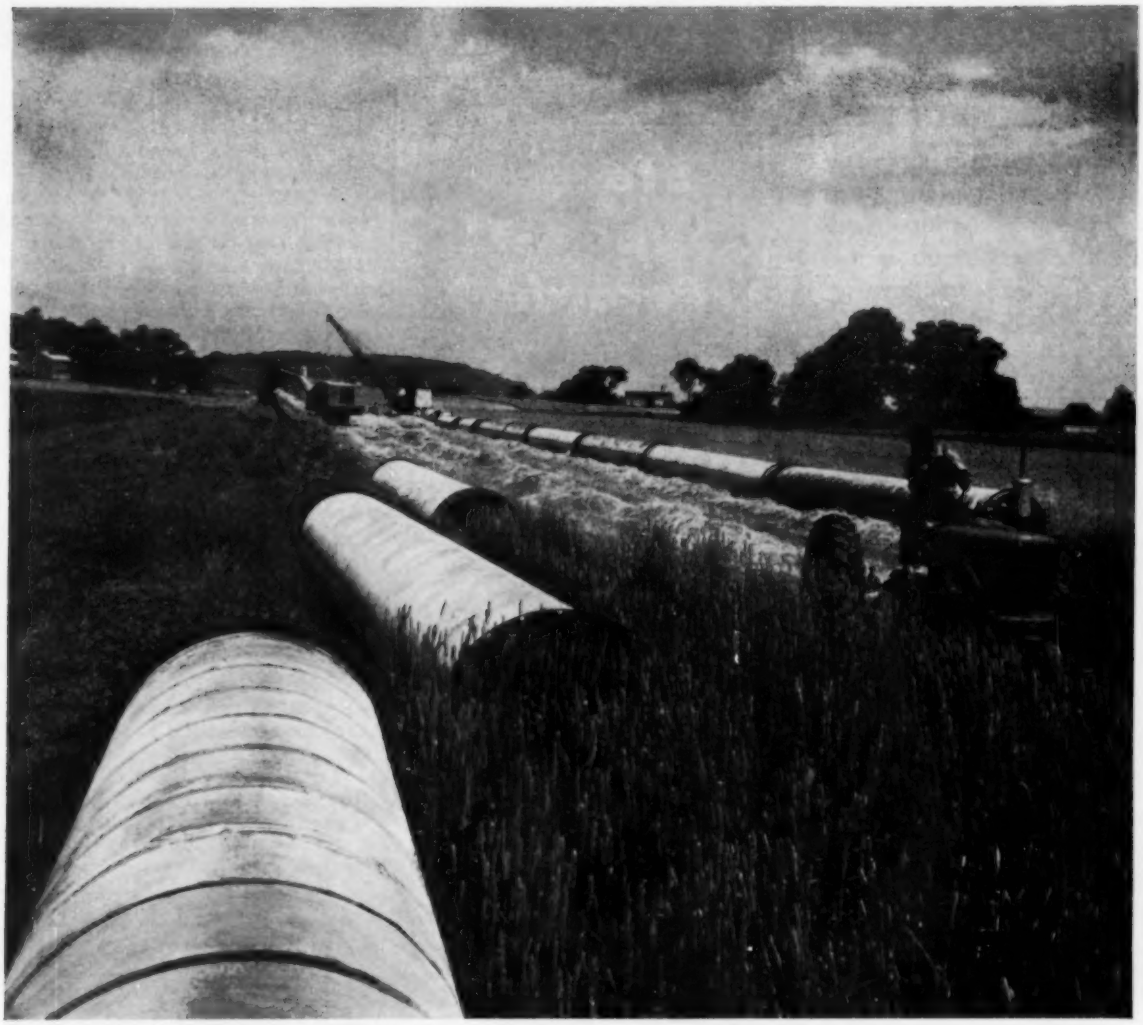
• • •

If you have a chlorine gas feeding problem, our engineers will gladly help you solve it. A call to GAspee 1-4302 in Providence . . . or to one of our local offices . . . will put us at your service. B-I-F Sales and Service Offices are located across the country for your convenience. Act today! Builders-Providence, Inc., 350 Harris Avenue, Providence 1, Rhode Island.

B-I-F INDUSTRIES

PROVIDENCE, RHODE ISLAND

METERS FEEDERS CONTROLS



"Planting" Lancaster's New Water Line

Lancaster, Pa., is one city that is taking vigorous steps to solve the problem of municipal water supply. Now under way is a vast water-supply project including construction of an intake, pumping station and filtration plant on the Susquehanna River, a 15-million gal reservoir and a 10-mile steel main. Completion of the pipeline early in 1957 will add 8 million gals per day to the city's water supply. The line's ultimate capacity will be 32 million gals per day.

The job requires 55,500 ft of 42-in.-ID x $\frac{5}{16}$-in. tar-enameled steel pipe, plus specials, fabricated at Bethlehem's Steelton, Pa., pipe shop, and trucked to the job site in 40-ft lengths. The portion of the line extending 31,400 ft from the river to the reservoir is being installed by Frank Kukurin & Sons, Inc., of E. McKeesport, Pa.; the 24,100-ft section into the city by Alconn Utilities, Inc., of Verona, N. J. The entire project was engineered by Gannett, Fleming, Corddry & Carpenter, Inc., of Harrisburg, for the City of Lancaster Authority.

How about *your* water supply plans? Let us show you the many advantages of planning for the future with tar-enameled steel pipe. Remember that *every length* of steel pipe is hydrostatically tested in the shop—your assurance of its strength, safety and freedom from leaks. For further information, contact the nearest Bethlehem sales office.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

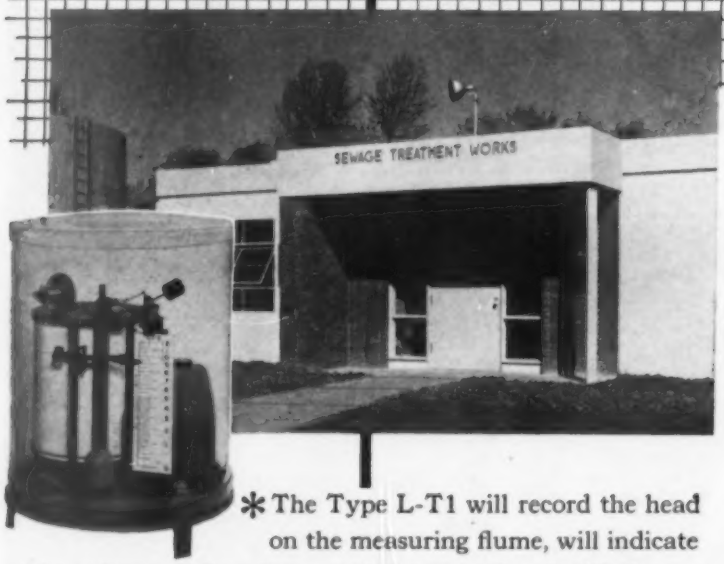
BETHLEHEM STEEL

BETHLEHEM STEEL

• If interested in equipment or literature mentioned below, mail a Reader Service Card with your name, address, and item key number.

PROBLEM:
To obtain at minimum cost the essential information on flow required for efficient operation of a small sewage treatment plant.

SOLUTION:
Stevens Type L-T1 Recorder*



* The Type L-T1 will record the head on the measuring flume, will indicate the volume of flow for any time interval and will give an instantaneous reading of the rate of flow. The head record, made on convenient rectangular coordinates, is basic information for permanent record from which plant operators and State Sanitary Engineers can check flows and volumes. The volume reading from the totalizer dials and the rate of flow indicator are essential for intelligent operation. Readings can be made in any desired volume and flow units.

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144 pages of technical data on recorder installations... plus a wealth of hydraulic tables and conversion tables. **Send $1.00 (No C.O.D.'s)**

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New Tapecoat Speeds Protective Applications

1112

The Tapecoat Company, Evanston, Ill., has developed a new Tapecoat product with a film-type, self-disposing liner.

Known as Tapecoat-SP, this new protective coating retains the same quality coal-tar-pitch-base protection characteristic, and the film-type liner permits easier and faster handling in the field because it widens the temperature range. The liner also is disposed of automatically in the torching application process.

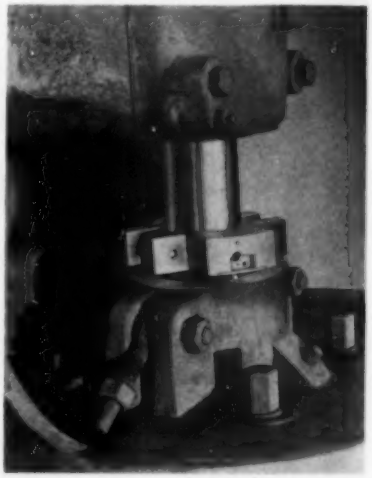
According to the announcement, Tapecoat-SP comes in widths from 2 to 6 inches, with each roll from 45 to 50 feet long.

New Tool For Mechanical Seal Installation

1113

Byron Jackson Pumps, Inc., Los Angeles, Calif., has developed a new precision hand tool to prepare pump stuffingboxes for mechanical seal installation. This new tool prepares a smooth gasket surface on the stuffingbox end to assure proper mechanical seal performance.

Consisting of a tool bit and holder, the stuffingbox tool machines the stuffingbox end at right angles to the shaft axis. The tool bit holder mounts on the shaft



with the tool bit against the stuffingbox end. The bit is adjusted to the bore and is worked outward by turning the shaft with a stillson or strap wrench.

The tool is chrome plated and is shipped complete with wrenches and two extra tool bits. It is available in three standard sizes to accommodate shaft sizes from ¾ to 3 inches.

CLOW CAST IRON PIPE

ON THE JOB

In hundreds of cities and towns expanding and improving their water supply and distribution service, you'll find Clow Cast Iron Pipe on the job. You'll find it, too, along our nation's newest toll roads and super-highways . . . in lanes and by-ways . . . in the development of more and more communities. In fact you'll find it 'most every place . . . wherever water must be conveyed underground, under pressure, to serve the vital needs of modern life.

And for good reason! Clow has been supplying pipe for these vital needs for generations. City officials, engineers, and waterworks men like what they call "the record": product, performance-proved; service, sure as sunrise. They know that when they put Clow pipe on the job, it will stay on the job—to serve for centuries.

SINCE 1878

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201-299 North Talman Avenue, Chicago 80, Illinois

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Eddy Valve Company, Waterford, New York
Iowa Valve Company, Oskaloosa, Iowa

• If interested in equipment or literature mentioned below, mail a Reader Service Card with your name, address, and item key number.

Fordin' Along...

Recent newspaper articles tell of a large city where the impounded supply is so nearly exhausted that it is necessary to bring in water from a distant river which has a high salt content. The brackish water is so unpalatable that quite a business has developed in the sale of fresh water in half gallon paper containers at 20c each. Few people realize that enough pure, safe water from the average public supply costs each citizen only about a nickel for all he can drink in a year.

One Bright $ Sign in the Water Line

Most operations in the water processing line cost money . . . with little or no opportunity to make them pay for themselves.

One bright spot in the line is the water meter, which measures and determines the income. And when the meter is well set it can earn more by being well protected but still easily available for reading and changing.

Many water utilities are realizing thousands of dollars annually in labor savings and in increased revenues from well-set and well-maintained meters.

Perhaps you, too, can show bigger net profits this inexpensive way.

Send for
Ford Catalog No. 56.

THE FORD METER BOX COMPANY, INC.
Wabash, Indiana

FOR BETTER WATER SERVICES

FORD

New Ditcher Digs in Its Own Track Marks

1114

Gar Wood Industries, Inc., Wayne, Mich., has developed a new ditcher able to dig to with 2¼ inches of the outside edge of either its right or left-hand crawler.

Designated as the Gar Wood-Buckeye 308-TP, the position of the ditcher's digging wheel can be shifted to three separate positions: To the left or right of the ditcher's mainframe, or in line with the mainframe.

Working specifications of the new ditcher include: Maximum depth of cut 5'6"; cutting width from 8 to 24 inches; and maximum obstruction clearance of 2¼ inches. Other features are: Hydraulic conveyor drive, hydraulic digging wheel hoist, variable bucket spacing, split-shaft excavator drive, and simplified, grouped operator controls.

Hand Tool For Drilling Through Soil

1115

The Hydrozion Engineering Co., Inc., Kansas City, Missouri, has developed the Hydrozion auger that will drill through dirt, hard pan, clay, sandy loam, shale, gravel and roots, in any direction, at a rate of up to 10 feet per minute, and at distances up to 100 feet.

The auger consists of a driving unit and a bit. The driving unit is of cast aluminum and a shaft which is chrome over nickel plate with bronze bearings and a neoprene-type seals.

An electric drill (½ inch or larger) is attached to the driving shank, a section of ¾ inch pipe is attached to the opposite end of the unit and the proper size (up to 36 inches diameter) bit is coupled to the end of this pipe. A garden hose and stop is attached to the driving unit and drilling commences.

GOING IN...

...a long-term community investment

It's Transite Ring-Tite Pressure Pipe

• Transite® Ring-Tite® Pressure Pipe is a community investment that pays off year after year!

Its remarkably high flow characteristics protect that investment by keeping maintenance and pumping costs at a minimum during its long service life.

Corrosion Resistant

Transite Pipe is strong, durable, and highly resistant to corrosion. And it is immune to tuberculation, the form of interior corrosion that chokes the flow and increases pumping costs. Transite cannot tuberculate, thus its original high flow capacity is maintained, and pumping costs are kept at a minimum year after year.

The Ring-Tite Coupling, with rubber rings compressed and locked in place forms a joint that is tight yet flexible. Rings cannot blow out, and the automatic separation of the pipes within the coupling helps to relieve line stresses.

For further information about Transite Pressure Pipe and the Ring-Tite Coupling, write for Booklet TR-160A. Address Johns-Manville, Box 14, New York 16, N.Y. In Canada, Port Credit, Ontario.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville TRANSITE PRESSURE PIPE

WITH THE **RING-TITE** COUPLING

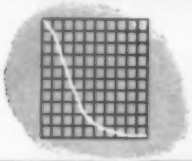
SMS ROTOVALVES

—STILL THE BEST VALVE YOU CAN BUY

Only Rotovalves give you all these features:

LEAST PRESSURE LOSS
Full line opening means less head loss, lower pumping costs.

EASIEST TO OPERATE
Hydraulic imbalance and mechanical design mean 1 man can close as fast as required. Less power needed in mechanical or electrical operation.



GREATEST INITIAL SHUT-OFF
Rotovalve 55% closed at 25% stroke, and 92% closed at 50% stroke. In comparison, gate valves only 18% closed at 25% stroke and 43% closed at 50% stroke.

MOST CONTROLLED CLOSING TIME
Closing as quickly as one second or as slow as needed. Fast initial closing limits reversal of flow.

MOST POSITIVE CLOSING
Drop-tight, positive closing. Self-purging, monel-to-monel seating. Pressure-tight bolted head, stuffing box, and machined and lapped seats.

In addition to all these features typical of SMS engineering, Rotovalves have a flexibility that makes them suitable for any type of operation, any method of control, or any sort of location.

For detailed information about SMS Rotovalves, Ball or Butterfly Valves, see our local representative or write to the S. Morgan Smith Company, York, Pennsylvania.

HYDRAULIC TURBINES · PUMPS · GATES & HOISTS · TRASH RAKES · ACCESSORIES

HYDRODYNAMICS

ROTOVALVES · BALL VALVES · BUTTERFLY VALVES · FREE-DISCHARGE VALVES · CONTROLLABLE-PITCH SHIP PROPELLERS

S. MORGAN SMITH

AFFILIATE: S. MORGAN SMITH, CANADA, LIMITED • TORONTO

W & SW Manufacturers' News

Motz Heads Pollution Activities at Pittsburgh Coke

Pittsburgh Coke and Chemical Company, Pittsburgh, Pa., has announced that D. J. Motz has been appointed Coordinator of Pollution Abatement. In this position, Mr. Motz will be in charge of all company efforts at air and stream pollution abatement.

Mr. Motz has had a varied engineering career in the seven years he has been with Pittsburgh Coke and Chemical Company. Mr. Motz's first assignment was in the Research and Development Department, after which he worked in control chemistry, drafting, and project engineering. Prior to his new appointment, Mr. Motz was assistant to the General Maintenance Superintendent.

In his new job, Mr. Motz will represent Pittsburgh Coke and Chemical Company on all pollution abatement committees authorized by the County Bureau of Smoke Control, the Ohio River Valley Sanitation Commission and other government agencies. He will also be responsible for the over-all plant program aimed at controlling air and stream pollution.

Great Grandsons Of Founder Join McDonald Company

A. Y. McDonald Mfg. Co., Dubuque, Iowa, has announced that Bruce McDonald and Robert McDonald, sons of D. L. McDonald, President of the company and grandson of the founder, have recently joined the firm.

Bruce McDonald has become a member of the Factory Production Department. He was formerly a First Lieutenant and pilot in the Air Force, and Engineering Maintenance Officer of B-47 jet bomber

(*Continued on page* 98A)

IN WITH THE NEW! "Century" Asbestos-Cement Pipe ready and able to replace more than 10 miles of a metallic pipeline weakened by external corrosion for the Jefferson County Fresh Water District #1, Sabine Pass, Texas.

Soil conditions led to the switch to non-corrosive "Century" Asbestos-Cement Pipe. Contractor: Hardin Construction Company, Houston, Texas.

non-corroding!

K&M "Century"® ASBESTOS-CEMENT PRESSURE PIPE

Throughout the country more and more communities are relying on water mains of K&M Asbestos-Cement Pipe . . . made of asbestos fiber and portland cement. It resists corrosion, is non-electrolytic, two of the many advantages which make for durability.

Pumping costs low and stable! There is no clogging to reduce flow and increase pumping costs with K&M Asbestos-Cement Pipe. It is non-metallic . . . non-tuberculating. Its bore remains smooth and clean.

Lower in initial cost! K&M Asbestos-Cement Pipe is light in weight—easily and inexpensively transported, stored and handled.

ENGINEERS WANTED—Career opportunities open for men qualified in product development, machine design, automation, plant management, plant engineering and applied research. Write to Director of Engineering, Keasbey & Mattison Company, Ambler 5, Pa.

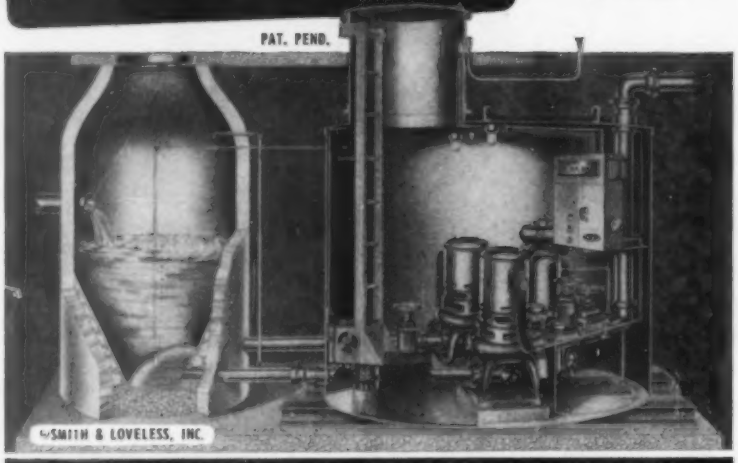
KEASBEY & MATTISON COMPANY • AMBLER • PENNSYLVANIA

K&M Cast in asbestos®

HUNDREDS OF INSTALLATIONS—IN 27 STATES!

Specify—
The Smith & Loveless
FACTORY-BUILT PUMPING STATION

PROVEN QUALITY—
WITH FACTORY-BUILT SAVINGS



THE MOST ADVANCED DESIGN IN SEWAGE PUMPING STATIONS

We specialize in building America's finest sewage lift stations. Acceptance proves their quality. Smith & Loveless offer you a complete line of six standard size lift stations with capacities from 20 GPM to 1600 GPM per pump or ejector. Larger capacity stations are built to your order.

- An integrated design, each piece proven by the test of time.
- Precision assembled by factory experts.
- Automatic dehumidifier to eliminate condensation.
- A central electrical control cabinet prewired and color coded.
- Shot blasted steel structure epoxy coated plus cathodic protection.
- Factory tested and adjusted by actual operation before shipment.
- Easily and quickly installed.
- Especially designed for minimum maintenance.

For Job Recommendations, complete specifications, and drawings—all part of the latest edition of the 100 page Smith & Loveless lift station Data Manual . . .

WRITE DEPARTMENT 20

S&L *Smith & Loveless, Inc.*
P. O. BOX 8172 KANSAS CITY, MISSOURI
Manufacturing Plant • Merriam, Kansas

REPRESENTATIVES IN PRINCIPAL CITIES

squadron at Smokey Hill Air Force Base in Salina, Kansas.

Robert McDonald is now working with the Company as a member of the Sales Department. He served as a Lieutenant JG in the Navy and was Chief Engineer on the McCoy Reynolds, destroyer escort based at Pearl Harbor, Honolulu, Hawaii.

The company is celebrating its centennial anniversary this year. The A. Y. McDonald Mfg. Co. was founded in 1856 by A. Y. McDonald, a Scot immigrant. The Company has been managed by members of the McDonald family since his death in 1894.

Seamless Rubber Acquires Kraloy Plastic Pipe

Kraloy Plastic Pipe Co., Inc., Los Angeles, Calif., has been acquired by The Seamless Rubber Company, New Haven, Conn.

Kraloy machinery and plant facilities at 4720 East Washington Blvd. have been thoroughly rehabilitated. Complete pipe testing equipment, as recommended by B. F. Goodrich Chemical Co. and Naugatuck Chemical Co., has been installed to stabilize quality control in the manufacture of plastic pipe.

Additional new facilities are scheduled for the Los Angeles Kraloy plant, and a parallel installation is planned for the Seamless plant at New Haven in the near future. Initially, Kraloy will produce polyvinyl chloride and Kralastic pipe.

Cooper-Bessemer Appoints Bartlett Dallas Branch Manager

Cooper-Bessemer Corporation, Mt. Vernon, Ohio, has announced the promotion of R. F. "Tad" Bartlett to Branch Manager of the Dallas Branch.

Under the new field office organization plan, Mr. Bartlett will be responsible for supervision of the Dallas Branch area activities on direct sales, engineering, and service contacts in the application of reciprocating and centrifugal compressors for pipe line, refinery and petrochemical use.

A graduate in Mechanical Engineering from Texas A & M, Mr. Bartlett has been associated with Cooper-Bessemer since 1934 in the field application of engines and compressors.

New Subscription Order Card

NOTE THE NUMBERS
they correspond with the
headings in our
EQUIPMENT AND LITERATURE COLUMNS
To receive further information
on any of the listed
EQUIPMENT OR LITERATURE
just circle the corresponding
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Fill in your name, address, title
and mail!
For your convenience these
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Water & Sewage Works

185 NORTH WABASH AVE. CHICAGO 1, ILL.

Gentlemen:

Please enter my new subscription to WATER & SEWAGE WORKS for the period checked below:

☐ Three Years—$6.00 ☐ Two Years—$4.50 ☐ One Year—$3.00

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No Postage Stamp Necessary If Mailed in the United States

BUSINESS REPLY CARD

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WATER & SEWAGE WORKS
185 NORTH WABASH AVENUE
CHICAGO 1, ILLINOIS

Postage Will Be Paid by Addressee

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BUSINESS REPLY CARD

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WATER & SEWAGE WORKS
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VILLAGE STATION
NEW YORK 14, NEW YORK

Postage Will Be Paid by Addressee

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WATER & SEWAGE WORKS

JUST CLIP THESE CARDS MARK AND MAIL— TO RECEIVE THE LATEST INFORMATION OR LITERATURE DESCRIBED IN THIS ISSUE

READER SERVICE CARD for

WATER & SEWAGE WORKS

Equipment — Products
Information — Literature

helping to mix a good, clear drink for 5 years

The city of Denver has, for many years, been noted for the purity of its drinking water. Transported from the western slopes of the Rockies through the famous Moffat Tunnel, the water is purified in the Moffat Filter Plant of the Denver Municipal Water Works.

It is here that *flexible* U. S. Pilot Pipe plays an important role — carrying the chemicals that purify the water—maintaining what is known as a good P.H. factor. This U. S. Pilot Pipe installation has given completely trouble-free service since the day it was put in. That was back in 1950—over five years ago.

With ordinary piping, lime in the chemicals builds up and clogs the pipe. But because U. S. Pilot Pipe is flexible, lime is easily broken loose by merely *tapping or walking the pipe!*

U. S. Pilot Pipe covers a range of working pressures — from 25 to 250 pounds—and handles a wide variety of chemicals and abrasives. It is custom-made to handle your specific requirements.

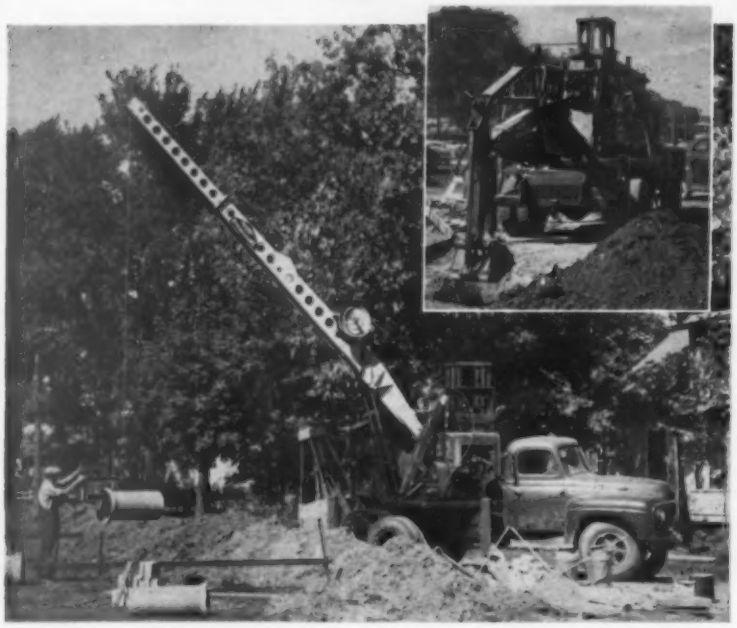
Contact our factory trained engineers at any of the 28 "U. S." District Sales Offices or write us at Rockefeller Center, New York 20, N. Y.

US RUBBER

Mechanical Goods Division

United States Rubber

QUICK CHANGE
Makes Hydrocrane Right for Water, Sewage Work



When your work calls for lifting, digging and trenching all in the same day, you need a machine that converts from crane to clamshell to hoe quickly and easily. That machine is the Hydrocrane. Owners report they can switch their Hydrocrane to hoe in less than one man-hour. Changing from crane to clamshell is just a matter of minutes.

Stop using the wrong front end just because changing front ends is a tough, time-consuming, uneconomical operation. Get a Hyrocrane! Take advantage of this versatile machine's precision control, the long reach of its telescoping crane boom in placing valves or pipe . . . in loading or unloading materials. Then, when needed, switch quickly to the hydraulic clamshell bucket to dig valve pits, manholes or catch basins.

When it comes to trenching, you'll find the fast and easy changeover to hoe gets you on the job sooner. And, once at work, the Hydrohoe's exclusive triple digging action — normal hoe arc, telescoping boom and wrist action at the dipper — keep output high, reduce hand trimming.

Have your Bucyrus-Erie distributor demonstrate quick change, as well as the many other features that make the Hydrocrane so right for municipal work. 130H56

BUCYRUS ERIE

SOUTH MILWAUKEE, WISCONSIN

Neptune Names John Moran In Six New York Counties

Neptune Meter Co., New York, N. Y., has announced that John J. (Jack) Moran of Franklin Square, N. Y. has been named sales representative in a newly formed district consisting of six southern New York State counties.

Charles W. Krause, New York Branch Manager for Neptune, said formation of the new district represents a realignment of geographical areas covered by Neptune salesmen.

Mr. Moran previously had worked with James L. Wheelin, in contracting municipal and privately operated water systems in the Long Island area. He will now travel in the area which includes the following New York counties: Westchester, Ulster, Sullivan, Dutchess, Orange, Putnam, and Rockland.

Mr. Moran will also be handling the distribution of gas meters, manufactured by the Neptune subsidiary, Superior Meter Co., in this six-county New York area and in New Jersey.

Badger Meter Opens Southwest Branch Plant

Badger Meter Mfg. Company, Milwaukee, Wisconsin, has announced that a new Southwest area branch plant with complete repairing and testing facilities has been opened in the Brook Hollow Industrial District of Dallas, Texas.

The plant has been established to handle all sales activities in meeting the increasing demand for the company's products in the Southwest and to extend to their customers even better delivery on

(*Continued on page* 102A)

Wrought Iron Pipe's built-in protection . . . always "on guard" against corrosion

Wrought iron pipe's "armed guard" against corrosion is a concentration of thousands of glass-like iron silicate fibers distributed throughout the metal.

These iron silicate fibers are relatively immune to corrosion . . . so any attacks by corrosion are evenly dispersed over the entire surface of the metal. As a result of this built-in protection, deep pitting and penetration are repelled . . . costly premature repairs and maintenance are eliminated.

Our booklet, "The ABC's of Wrought Iron" tells more of this story. You'll find it profitable reading. Write for your copy today.

A. M. Byers Company, Pittsburgh, Pa. Established 1864. Division Offices in Boston, New York, Philadelphia, Washington, Atlanta, Chicago, St. Louis, Houston, San Francisco. International Division: New York, N. Y.

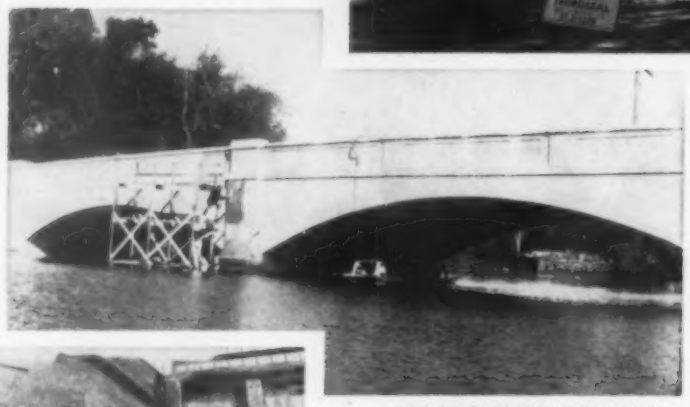
Available in Canada and throughout the world.

BYERS *Wrought Iron Tubular and Hot Rolled Products*

ALSO ELECTRIC FURNACE QUALITY STEEL PRODUCTS

It's *New Again* with THORITE and THOROSEAL

Freeze-thaw cycle following water and moisture penetration, also swelling of reinforcing rods from moisture contact, cause masonry destruction.



BRIDGE OVER CONCORD RIVER
ROUTE 3, BELLERICA, MASS.

Workmen on scaffold patch spalled and cracked concrete with THORITE and seal surface with THOROSEAL.

Area at left chipped to sound masonry. It will then be patched with THORITE *Nonshrink, Non-slump 20-Minute Set Patching Mortar,* without necessity of costly forming, finished by application of Thoroseal.

Request Circular No. 16 and 20.

Write for our 16 page "How to Do It"

STANDARD DRY WALL PRODUCTS, INC.
NEW EAGLE, PENNSYLVANIA • CENTERVILLE, INDIANA

meters and parts. It will be under the supervision of Norman H. Abrams, Southwest sales manager. New meters and repair parts will be warehoused and the services of experienced Badger sales engineers will be available at all times, especially to assist small water works operators.

Housed in a new, modern building, the new Badger Meter branch is convenient and easy to reach, being just a short drive from the heart of Dallas.

Simplex Appoints Stallings Co. As Representative

Simplex Valve & Meter Company, Lancaster, Pa., has announced the appointment of the Ward K. Stallings Company of 3120 Maple Drive, N.E., Atlanta 5, Georgia as its representative for the states of Alabama and Georgia.

The Stallings Company can draw on a great deal of experience to aid its customers since the three members of the firm have a wealth of background in the filtration and waste fields. Mr. Stallings was Chief Engineer for a period of 6 years with Kielley & Mueller, Inc. Mr. Carl L. Fox, Jr., who is a licensed Mechanical Engineer in both Alabama and Georgia, has had over 5 years experience in the Instrumentation and Electronics field. The third member of the firm, Mr. Roy W. Freeman, has over 5 years experience as a Sales Engineer in the Waste and Sewage field and is well known throughout the territory.

Templeton Joins Alloy Steel As Chief Metallurgist

Alloy Steel Products Co., Inc., Linden, N. J., has announced the appointment of Harold C. Templeton as chief metallurgist. In this post, Mr. Templeton will direct metallurgical research in corrosion-resistant alloys and supervise the systhesis and composition of alloys used in Aloyco corrosion-resistant valves. He will also furnish corrosion consulting services to Aloyco customers.

Mr. Templeton was formerly chief metallurgist for the Lebanon Steel Foundry. He is a Metallurgical Engineer, receiving his degree from the Colorado School of Mines, and served 5 years as an officer in the Corps of Engineers during World War II.

Purcelli Named General Manager of New Rockwell Plant

Rockwell Manufacturing Co., Pittsburgh, Pa., has announced that Ralph A. Purcelli, former assistant general manager of the company's gas regulator plant at Norwalk, Ohio, has been named general manager of the New Rockwell plant at Statesboro, Georgia.

A native of Pittsburgh, Mr. Purcelli joined Rockwell in 1936, became general foreman of the Nordstrom valve department at Pittsburgh in 1943, general foreman of meter and regulator assembly in 1950, general superintendent of the Barberton, Ohio, valve plant in 1951 and assistant general manager at Norwalk in 1954.

Cook Well Strainer Moves To New Offices

The Cook Well Strainer Co., Cincinnati, Ohio has moved to its new plant and offices located at 6330 Glenway Avenue, Cincinnati. The new telephone number is Humboldt 1-8800.

The recently completed plant contains 35,000 square feet of shop space, modern offices and is strategically situated to offer the finest in transportation services to their drillers and jobbers.

Adams Pipe Repair Appoints Swanson

Adams Pipe Repair Products, El Monte, California, has announced the appointment of George Swanson, 226 W. 110th Place, Chicago, Illinois, as regional sales representative.

Mr. Swanson will represent the company in the states of Illinois, Wisconsin, Indiana and Michigan.

Baily Meter Adds Two Stories To Wickliffe Plant

Bailey Meter Company, Cleveland, Ohio, has announced plans for a two-story addition to the company's new plant in Wickliffe, Ohio.

Scheduled for completion in July 1957, the new addition will add 72,000 sq. ft. to the 165,000 sq. ft. one-story unit completed last year. The company has a main plant in Cleveland—8 miles west of the Wickliffe plant—and 24 district offices throughout the United States.

- **"...our CLEVELANDS dig them all...** in all types of soil and terrain . . . swamps, sand, rock, shale, clay . . . stumps, boulders and other obstructions . . . hill and flat land . . ." says Hubert S. Eley, vice president of the D. A. Foster Trenching Corp., Merrifield, Va. Starting with a rented Cleveland in 1949, the firm now owns 10 (Models 95, 110 and 140) and keeps them constantly busy.
- **"...in 15 or 20 minutes** we complete a gas or water house connection with one of our Clevelands."
- **"...1800 to 2000 feet of 30" deep trench per day...** our average production on building footings with a Cleveland."

- **"...not necessary to stockpile large amounts of parts for CLEVELANDS."**
- **"...CLEVELANDS operate a working week on a tank of fuel."**
- **"...all-around adaptability...** just one of the many reasons why we prefer Clevelands . . . besides utilities work and footings, we use them for drainage trenching, septic tank installations and a wide range of other applications."
- **"...our CLEVELAND 140 paid for itself within 30 days."**
- **"...best all-purpose trenchers made...** the easiest to operate . . . and the longest lasting."

Cleveland users everywhere report similar satisfactory experience . . . it's typical of the performance you can depend upon with Clevelands.

THE CLEVELAND TRENCHER CO.

20100 ST. CLAIR AVENUE • CLEVELAND 17, OHIO

Good Everywhere

TENNESSEE CORPORATION

Ferri-Floc
FERRIC SULFATE

The Superior
COAGULANT
With the Plus
FACTORS—

1. Excellent Taste and Odor Control
2. Coagulation Over Wide pH Range
3. Rapid Floc Formation
4. Color Removal
5. Bacteria Removal
6. Turbidity Removal
7. Manganese and Silical Removal
8. Ease of Operation
9. Economical
10. Increased Filter Runs

Ferri-Floc gives smoother, more efficient and trouble free operation. Whatever your particular water treatment problem may be, you can depend on Ferri-Floc doing a superior job and doing it efficiently and economically—Ferri-Floc is a free flowing granular salt which can be fed with few modifications through any standard dry feed equipment. It is only mildly hygroscopic, thereby permitting easy handling as well as storage in closed hoppers over long periods of time.

WATER TREATMENT

Efficient coagulation of surface or well waters. Aids taste and odor control—Effective in lime soda-ash softening. Adaptable to treatment of nearly all industrial waters.

SEWAGE TREATMENT

Ferri-Floc coagulates water and wastes over wide Ph ranges—it provides efficient operation regardless of rapid variations of raw sewage and is effective conditioning sludge prior to vacuum filtration or drying on sand beds.

SULFUR DIOXIDE

SULFUR DIOXIDE is effectively used for dechlorination in water treatment and to remove objectionable odors remaining after purification.

LIQUID SULFUR DIOXIDE HIGHEST QUALITY SO_2

COPPER SULPHATE

COPPER SULFATE

COPPER SULFATE will control about 90% of the microorganisms normally encountered in water treatment more economically than any other chemical.

Free Booklet—

Let us send you without charge, a 38 page booklet that deals specifically with all phases of coagulation—just send us a postal card.

TENNESSEE CORPORATION

617-29 Grant Building, Atlanta, Georgia

Fischer & Porter Appoints Regional Managers

Fischer & Porter Co., Hatboro, Pa., has announced the appointment of two regional managers for data reduction and automation equipment.

Harold L. Russell becomes Eastern Regional Manager, with headquarters in Hatboro, Pa. For the past seven years, Mr. Russell, an electrical engineering graduate of the University of Pennsylvania, was employed as a sales engineer by Minneapolis-Honeywell.

William C. Abbey becomes Southwest Regional Manager with headquarters in Houston, Texas. A mechanical engineering graduate of Texas A & M, Mr. Abbey's previous associations were with Manning, Maxwell, and Moore as a sales engineer, and with Socony-Mobile as process engineer.

Smith-Blair Promotes Ball

Smith-Blair, Inc., South San Francisco, Calif., has announced the promotion of Richard A. Ball from production engineer to sales engineer.

Mr. Ball is well experienced in asbestos-cement pressure pipe requirements having been connected with the Keasby-Mattison "Century Pipe" organization for several years. He will headquarter at the company's South Gate, California branch.

Chain Belt Appoints Charles Smith Regional Sanitary Engineer

Chain Belt Co., Milwaukee, Wis., has announced the appointment of Charles E. Smith as Regional Sanitary Engineer for the Northeastern United States. With headquarters in Philadelphia, he will concentrate on the technical aspects of Rex Sanitation Equipment.

He is a graduate of Purdue, with a Masters Degree, majoring in Sanitary Engineering, and served in the U. S. Air Force for 3 years as a Sanitary Engineer, before joining Chain Belt in 1955.

Mr. Smith will travel with a station wagon equipped with basic laboratory apparatus to assist him in check-testing the performance of Rex equipment in existing installations, and allow him to make preliminary field studies for new applications to industrial waste treatment problems.

At Last!!

AUTOMATIC DUMPER

For Power Bucket Machines

Can be installed on all models of Flexible Machines.

SPEEDS UP
Operation

SAVES
One man

Send for Information

FLEXIBLE INC.
3786 Durango Ave., Los Angeles 34, Calif.
(Distributors in Principal Cities)

"Our ROYER has eliminated our last major plant problem"

from an Ohio sewage treatment plant*

This sewage treatment plant had a problem of sludge disposal. The cost of incineration was prohibitive and the sludge could not be disposed of in caked form as fertilizer, even without charge.

In April 1954 they purchased a Royer Sludge Disintegrator and during the first seven months of operation earned 90% of its cost. They are currently selling their entire output of completely shredded, pulverized, trash free, ready-to-use fertilizer at $5.00 per cubic yard. In addition to replacing a cost of disposal with a cash income, they have built up good will with the citizens of their community by supplying an easily handled, useful fertilizer at a moderate cost.

Write for details on this "income producing" equipment. Available in capacities from 1 to 150 cubic yards per hour in electric motor, gasoline engine or belt-to-tractor drives. Turn an "expense" item into a "profit" with a Royer.

**name on request*

ROYER foundry & machine co.
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ROYER

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how to CUT CORROSION LOSSES

a report by Koppers Company, Inc.

James Beaumont
Project Leader

How thick should a protective coating on above ground installations be? This is a question that is asked of our Technical Department quite often.

* * *

All other factors being equal, the thicker the protective coating, the longer its service life. Basically, the coating thickness required is dictated by the degree of protection desired and the conditions under which the coating system must perform. Specifically, you need to know the following things about each job: (1) What is the corrosive environment . . . mild? . . . severe? . . . acid? . . . saline? (2) How long must the coating last? . . . is it practical to re-coat every year or are thicker, longer-lasting coatings desirable? (3) The roughness of the surface: since valley-to-peak distance may be as great as 8 to 10 mils, it is vital that peaks be fully covered to the specified thickness. (4) Finally, you should figure the cost of "down time" in terms of lost production.

Another factor in determining coating thickness is the accessibility of the structure. Our pre-coating surveys always include a careful analysis of inaccessible areas where a thicker coating is recommended simply to eliminate for as long as possible the need to re-coat the hard-to-get-at places. This reduces yearly costs by lessening chances of corrosion in places that are passed-by in routine inspections or that are inaccessible.

* * *

The "Steel Structures Painting Manual" (Vol. 1) points out that average industrial conditions warrant a 5-mil coating and severe corrosive conditions need a coating that *must* exceed 10 mils. Generally, our applications research corroborates these recommendations.

It should be remembered that the inherent characteristics of coating materials determine the maximum thickness to which they may be applied in a single coat. For example, some cold-applied coatings of coal-tar base give, in a single coat, a film up to eight times the thickness of ordinary paints. Coal-tar enamels, widely used for pipeline applications, can be applied much more heavily, normal thickness being between 60 and 100 mils. Of course these heavier single-coat thicknesses mean reduced application time and labor costs as well as longer life.

* * *

Every attempt should be made to "police" the application to make sure that the desired thickness is obtained. Checks on wet or dry film thickness can be made with mechanical, electrical or magnetic gauges designed for the purpose.

* * *

If you have specific problems on protective coating thickness . . . or any corrosion-control problems . . . we'd be glad to hear from you. Write to Koppers Company, Inc., Dept. 109L 1301 Koppers Building, Pittsburgh, Pa. District Offices: Boston, Chicago, Los Angeles, New York, Pittsburgh and Woodward, Ala. In Canada: Koppers Products, Ltd., Toronto, Ontario and Edmonton, Alberta.

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New Literature

Delivery Date Calculator

1116

The Nooter Corporation, St. Louis, Mo., has just produced a handy device which they call the **"Delivery Date Calculator".**

The device was produced after a survey showed that the company's purchasing and engineering personnel had improvised many make-shift tables of various kinds to provide a rapid reference to future delivery dates.

Produced on heavy-weight varnished board, the disc-type device determines the future date immediately. The user simply sets the arrow opposite date of order and gets a direct reading of estimated delivery date.

Rubber Seat Butterfly Valve Manual

1117

The Henry Pratt Co., Chicago, Illinois, has just released a 40-page, 2-color manual on **Butterfly Valves.**

The manual profusely illustrated with photographs and drawings was designed to help engineers select valve types, understand their characteristics, and determine space requirements. It includes such useful data as: pressure drop and flow tables, conversion tables, theory and application, recommended materials, and complete descriptions of Henry Pratt Rubber Seat Butterfly Valves in sizes from 4 inches diameter and up.

Questions and Answers About Vertical Turbine Pumps

1118

Layne & Bowler, Inc., Memphis, Tenn., has just published a comprehensive book on **The Answers to Your Questions About Layne Vertical Turbine Pumps.**

Written by one of the foremost authorities on vertical turbine pumps, this 72-page hand-bound book covers the use of pumps for municipalities, industry and irrigation.

Section One of the book is devoted to a study of the methods of selecting deep well centrifugal pumps to attain optimum efficiency. Charts for determining size and type of vertical pumps operat-

ing from 585 RPM to 1750 RPM are included.

Topics included for discussion are: Centrifugal pumps designed for underground waters; Turbine pumps as used for well equipment in small cities; Column life of deep well pumps; and Vertical short-coupled turbine pumps.

In a section entitled "A Corrosion Problem—3000 Feet Deep," the author describes the actual construction of a well which supplies water to the City of Dallas, Texas—a well which reaches down 2886 feet and delivers over 2,225,000 gallons per day.

The entire text is supplemented with graphic tables, photographs, drawings and charts, to present a thorough reference book on vertical turbine pumps.

Requests for copies must be sent on company letterhead.

Power Pipe Pushing And Pulling

1119

Mercury Hydraulics, Inc., Denver, Colorado, has just published a handbook on **Power Pipe Pushing.**

Subtitled "The fast answer to underground installation of rigid and flexible pipe or conduit", the handbook illustrates and describes various methods of installing pipe underground with the use of powered pipe pushers.

Complete instructions are given on the preparation of the pipe pusher, the access trench, and maintenance. Diagrams and text show different methods of application for all types of pipe pushing or pulling.

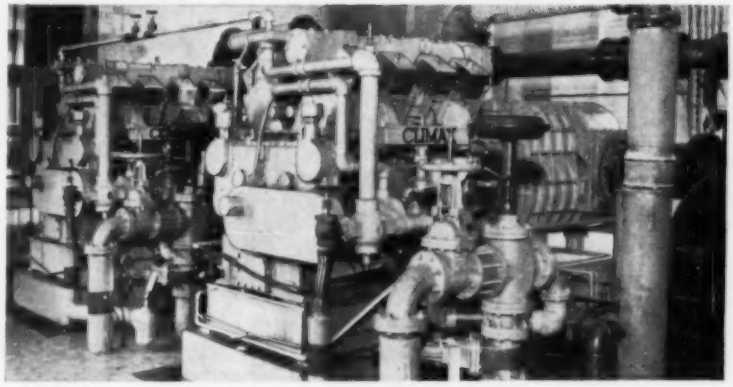
How American Standards Are Made

1120

The American Standards Association, New York, N. Y., has published a booklet on **How American Standards Are Made.**

The booklet describes the three ways standards become nationally-accepted and approved as American Standards. It tells who makes these american standards and why, and who uses them.

It explains what the American Standards Association is, how it guards the processes through which American standards are developed, and how it operates impartially for the manufacturer, the consumer and the general public.



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The York, Pennsylvania, activated sludge type sewage treatment plant, serving 90,000 persons in York and surrounding communities, employs 3 Climax Engines.

The two engines pictured are Climax 8 cylinder V-Type, 7 x 7 sewage gas engines direct connected to 3500 CFM blowers requiring 149 H.P. at 790 RPM.

The third engine, not illustrated, is a Climax 12 cylinder V-type, 7 x 7 sewage gas/gasoline engine which drives a 150 KW, 480 volt, 720 RPM generator. It provides electric power when sufficient gas is available and serves as a stand by unit in emergencies.

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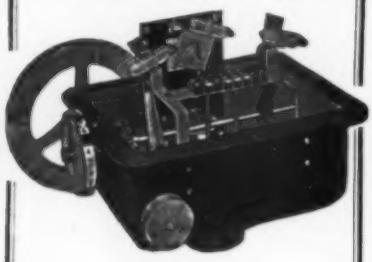

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Methods of Applying Antifoam Agents

1121

Hodag Chemical Corp., Chicago, Ill., has just released an illustrated 4-page folder on **Methods of Application For Antifoams.**

Application methods described in the folder range from simple manual feeders to complex automatic feeding systems. These antifoam application methods are generally adaptable to most manufacturing operations. All methods described have been field-tested and proven to provide efficient foam control.

Sewer Joint Compounds

1122

K. T. Snyder Company, Houston, Texas, has just published a new engineering brochure on the company's line of **Sewer Joint Compounds.**

The brochure describes GS-703, a hot-poured asphaltic-base compound, Root-Seal, a hot poured plastic-base compound, and GS-702, a ready-mixed, cold applied compound.

The brochure also presents photographs of installations, tests, engineering data and specifications, application procedures and estimating tables.

Installation of Rigid Koroseal Pipe

1123

The B. F. Goodrich Co., Plastic Products, Marietta, Ohio, has just released an 8-page illustrated bulletin on its line of **High Impact Rigid Koroseal Pipe, Fittings and Valves.**

The brochure explains how Koroseal pipe is installed, reviews product applications and describes physical properties. Also described is the use and installation of Koroseal valves. The back page is devoted to a chart listing common chemicals handled by Rigid Koroseal pipe, fittings and valves.

Case Histories of Major Tunneling Projects

1124

The Master Builders Co., Cleveland, Ohio, has published a study of **12 Major Tunneling Projects** constructed in the western hemisphere in recent years. Each case history is a report of the excavating and concreting problems encountered and successfully solved on these projects.

This book will prove a valuable aid to any engineer considering a tunnel project regardless of size. The three basic tunnel types, highway, railway, and water tunnels and their construction techniques are clearly illustrated by photos and accompanying texts.

Turbine-Type Process Pumps

1125

Aurora Pump Division of the New York Air Brake Co., Aurora, Illinois, has just published a bulletin describing the company's new line of **Single and Double Stage Turbine-Type Process Pumps.**

According to the bulletin, the new pump line is available in any machinable alloy such as stainless steel, nickel, monel etc., and is designed to handle liquified petroleum gases, refrigerants and other light, non-viscous liquids.

Elevated Steel Tanks

1126

Pittsburgh-Des Moines Steel Company, Pittsburgh, Pa., has just released a new edition of their brochure on **Modern Water Storage in Elevated Steel Tanks.**

The 20-page brochure includes dimensional data and capacities

(*Continued on page* 110A)

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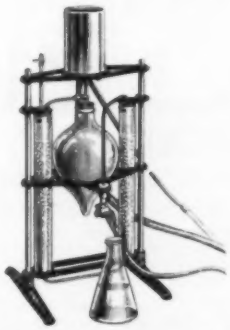

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Chemical Feeders and Mixers

1127

Infilco Inc., Tucson, Arizona, has just published a bulletin on **Chemical Mixers and Feeders.**

It is an 8-page brochure, with numerous illustrations and diagrams. A complete description and performance data on the mixers and feeders is also included.

Coagulator Bulletin

1128

Hungerford & Terry, Inc., Clayton, N. J., has just published a bulletin on the **Hungerford & Terry Coagulator.**

The bulletin describes the coagulator as a high speed up-flow solids contact type coagulation and settling unit designed for use in water clarification, water softening and waste water treatment.

According to the bulletin, the coagulator is built of concrete, steel or wood, square or round and both with and without sludge scraper type of bottom.

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INDEX TO ADVERTISERS

Albright & Friel, Inc. 111A
Alvord, Burdick & Howson 111A
*American Vitrified Products Co. 89A
*Anthracite Equipment Corp. 110A

Badger Meter Mfg. Co. 27A
Baffa, John J. 111A
Baker, Jr., Michael 111A
*Bethlehem Steel Company 91A
Betz, W. H. & L. D. 111A
*B-I-F- Industries, Inc. Inside Back Cover; also 90A
*Blackburn-Smith Mfg. Co. 109A
Black & Veatch 111A
Bogert & Childs 111A
Boyle Engineering 111A
Bowe, Albertson & Associates 111A
Buck, Seifert and Jost 111A
Bucyrus-Erie Company 100A
Buffalo Meter Co. 25A
*Builders-Providence, Inc. Inside Back Cover; also 90A
Burgess & Niple 111A
Burns & McDonnell 111A
Byers Company, A. M. 101A

Calgon, Inc. 30A
Camp, Dresser & McKee 111A
Capitol Engineering Corporation 111A
Carborundum Company 28A
Cast Iron Pipe Research Ass'n 18A-19A
*Chemco 108A
Chester Engineers, The 111A
*Chicago Bridge & Iron Co. 21A
*Chicago Pump Company 79A
*Cleveland Trencher Co., The 102A
Climax Engine & Pump Mfg. Co. 107A
Cole & Son, Chas. W. 111A
Clow & Sons, James B. 93A
Consoer, Townsend & Associates 111A
Cotton, Pierce, Streander, Inc. 111A

Darling Valve & Mfg. Co. 16A
DeLaval Steam Turbine Co. 32A
DeLeuw, Cather & Company 111A

Economy Pumps, Inc. 84A

Fairbanks-Morse & Co. 5A
Fay, Spofford & Thorndike 111A
Finkbeiner, Pettis & Strout 111A
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Flexible, Inc. 105A
Ford Meter Box Co. 94A
Freese, Nichols & Turner 112A

Gannett Fleming Corddry and Carpenter, Inc. 112A
Gilbert Associates, Inc. 112A
Glace & Glace 112A
Greeley & Hansen 112A

*Hardinge Company, Inc. 88A
Haskins, Riddle & Sharp 112A
Havens & Emerson 112A
Hayden, Harding & Buchanan 112A
Hazen & Sawyer 112A
Healy-Ruff Company 108A
Henningson, Durham & Richardson 112A
Hersey Manufacturing Company 33A
Homelite Corp. 3A
*Hydraulic Development Corp. 107A

Industrial Chemical Sales 24A
Infilco Inc. 85A

*Jeffrey Mfg. Co. 12A
Jennings-Lawrence Co., The 112A
*Johns-Manville 95A
Jones, Henry & Williams 112A

Keasby & Mattison Company 97A
Kenan & Associates, R. L. 112A
Kennedy, Clyde C. 112A
Knowles, Inc., Morris 112A
Koppers Co., Inc. 106A

Lanning Sanitary Engr. Co., Inc. 112A
Leopold & Co., F. B. 110A
Leupold & Stevens 92A
*Link-Belt Co. 7A
Lock Joint Pipe Company Inside Back Cover
Lockwood Greene Engineers, Inc. 112A
Loizer Co., Wm. S. 112A

*M & H Valve & Fittings Co. 86A
Metcalf & Eddy 112A
Minneapolis-Honeywell Reg. Co. 8A
Mueller Company 22A-23A

*Neptune Meter Company 34A
Nussbaumer, Clarke & Velzy, Inc. 112A

*Olin Mathieson Chem. Corp. 9A
Oliver Corp. 29A

*Pacific Flush Tank Company 14A
Parsons, Brickerhoff, Hall & MacDonald 112A
Pennsylvania Salt Manufacturing Co. 17A
*Permutit Company 4A
*Phipps & Bird, Inc. 109A
Pirnie Engineers, Malcolm 112A
Pitometer Associates, Inc., The 112A
*Pittsburgh Coke & Chem. Co. 13A
*Pittsburgh-Des Moines Steel Co. 26A
Pressure Concrete Co. 109A
*Price Bros. Company 83A
Purcell, Lee T. 113A

Riddick, Thomas M. 113A
Robert and Company Associates 113A
*Roberts Filter Mfg. Co. 108A
Rockwell Mfg. Co. 31A
Royer Fdry. Mach. Co. 105A

Sirrine Company, J. E. 113A
Smith & Associates, Benjamin L. 113A
*Smith & Loveless, Inc. 98A
*Smith, S. Morgan 96A
*Smith Mfg. Co., A. P. 87A
Standard Day Wall Products, Inc. 102A
Stanley Engineering Company 113A
Stilson & Associates, Alden E. 113A

*Tennessee Corporation 104A

Uhlman & Associates 113A
*U. S. Pipe & Foundry Co. 15A
U. S. Rubber 99A

*Walker Process Equip. Inc. 81A
*Wallace & Tiernan, Inc. Back Cover
Washington Aluminum Co., Inc. 110A
Wertz Engineering Co., Inc. 113A
Westinghouse Electric 10A-11A
Weston & Sampson 113A
Whitman & Howard 113A
Whitman, Requardt & Associates 113A
Wilkinson Products Co. 108A

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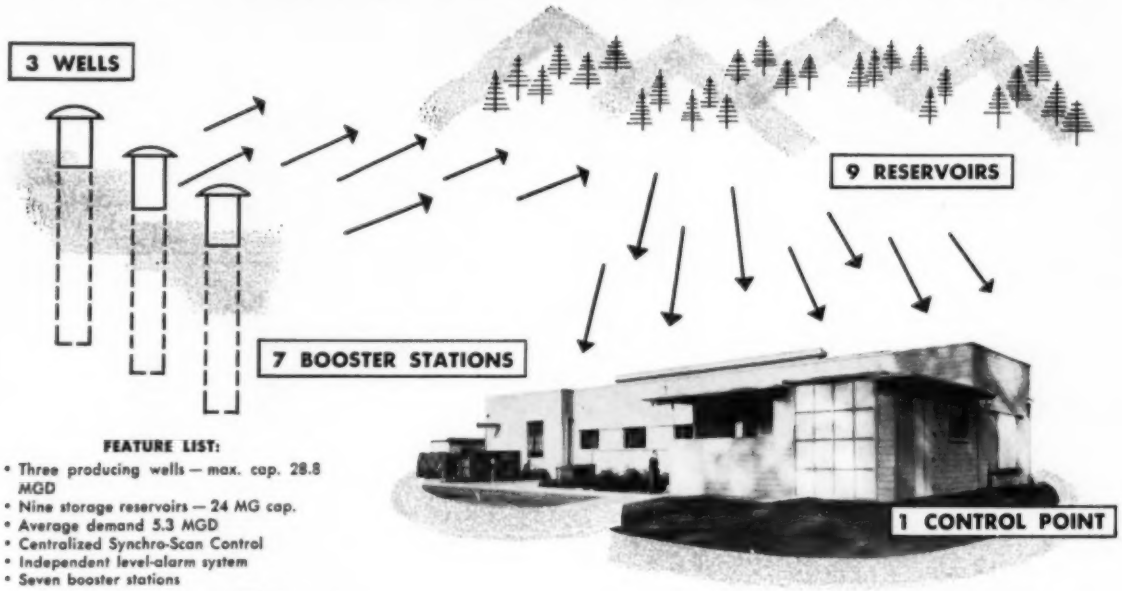

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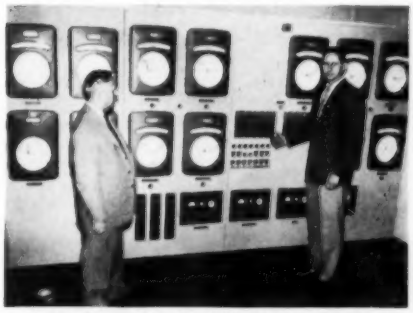

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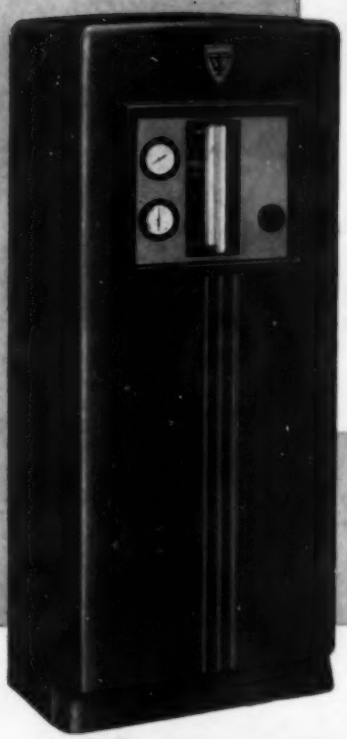

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